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SPECIAL SECTION: COMMUNITY-BASED PREFERENCES
AND QUALITY-OF-LIFE SCORES FOR US ADULTS

Report of Nationally Representative Values for the Noninstitutionalized US Adult Population for 7 Health-Related Quality-of-Life Scores

*Janel Hanmer, William F. Lawrence, MD, MS, John P. Anderson, PhD,
Robert M. Kaplan, PhD, Dennis G. Fryback, PhD*

Background. Despite widespread use of generic health-related quality-of-life (HRQoL) scores, few have publicly published nationally representative US values. **Purpose.** To create current nationally representative values for 7 of the most common HRQoL scores, stratified by age and sex. **Methods.** The authors used data from the 2001 Medical Expenditures Panel Survey (MEPS) and the 2001 National Health Interview Survey (NHIS), nationally representative surveys of the US noninstitutionalized civilian population. The MEPS was used to calculate 6 HRQoL scores: categorical self-rated health, EuroQoL-5D with US scoring, EuroQoL-5D with UK scoring, EuroQoL Visual Analog Scale, mental and physical component summaries from the SF-12, and the SF-6D. The authors estimated Quality of Well-being

scale scores from the NHIS. **Results.** They included 22,523 subjects from MEPS 2001 and 32,472 subjects from NHIS 2001. Most age and sex categories had instrument completion rates above 85%. Females reported lower scores than males across all ages and instruments. In general, those in older age groups reported lower scores than younger age groups, with the exception of the mental component summary from the SF-12. **Conclusion.** This is one of the first sets of publicly available, nationally representative US values for any standardized HRQoL measure. These values are important for use in both generalized comparisons of health status and in cost-effectiveness analyses. **Key words:** health-related quality of life; EQ-5D; SF-12; SF-6D; QWB; national norms. (*Med Decis Making* 2006;26:391–400)

There is a wide interest in measuring health-related quality of life (HRQoL) to both describe the health state of individuals or groups and measure the health change these individuals or groups experience over time. To meet this interest, researchers have developed a variety of off-the-shelf HRQoL measures for general and disease-specific health. Some of the general measures have scoring

algorithms that yield utility values, with dead anchored at 0 and full health anchored at 1.0. Of these general measures, some also allow scores less than 0 to indicate states worse than death. These utility values are interval scaled and preference based, so they are appropriate for construction of quality-adjusted life-years to inform decision making and in cost-effectiveness analyses.¹ Scores that are not based on utility values can be used for more general comparisons of health status.

Despite widespread use of HRQoL measures, only 3 publicly published articles provide nationally representative US values for general health measures that researchers and policy makers can use to compare individuals or groups because these measures have previously not been included in nationally representative surveys. Nationally representative values have been published for other countries, including Australia (SF-36),² Ireland (SF-36),³ New Zealand (SF-36),⁴ Norway (SF-36),⁵ Singapore (SF-36),⁶ Spain (SF-36 and HUI-3),^{7,8} and the United Kingdom (SF-36).⁹

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Options for comparison within the United States depend on the measure used. For the SF-36 version 1, McHorney and colleagues published values for both telephone and mail administration from a nationally representative sample in 1992 by age group for the 8 SF subscales.¹⁰ For the Quality of Well-being (QWB) Scale, Anderson published estimates using National Health Interview Survey data between 1979 and 1996.¹¹ For the EuroQol-5D (EQ-5D) with US scoring and Health Utilities Index (HUI) Mark 2 and 3, Luo and colleagues published values from a nationally representative sample who self-completed the questionnaire in a home visit survey in 2002.¹² For the SF-36 and SF-12 version 2 family of measures, there are privately published proprietary values that the vendor reports to be from a 1998 nationally representative sample.¹³ For the SF-36 version 1 and QWB Scale, there is a peer-reviewed journal article that lists values from a community sample that is commonly used in lieu of nationally representative values.¹⁴

In this report, we present age- and sex-stratified nationally representative values for several commonly used preference-based and non-preference-based HRQoL scores. We use data from the 2001 wave of the Medical Expenditures Panel Survey (MEPS), a nationally representative sample of the US noninstitutionalized civilian population. The 2001 wave of MEPS included 3 off-the-shelf measures of HRQoL: the EQ-5D, the EuroQol Visual Analog Scale (EQ-VAS), and the SF-12 version 1. From these 3 measures, we obtained 6 HRQoL scores: categorical self-rated health, EQ-5D with US scoring,¹⁵ EQ-5D with UK scoring,¹⁶ EQ-VAS, mental and physical component summaries from the SF-12,^{17,18} and the SF-6D.¹⁹ We estimated QWB^{11,20} scores from the 2001 National Health Interview Survey (NHIS), another nationally

representative survey of the US noninstitutionalized population that is used as the sampling frame for MEPS.

SUBJECTS AND METHODS

Subjects

Data for this study come from 2 sources, the 2001 MEPS and the 2001 NHIS surveys. The MEPS is a nationally representative survey of health care utilization and expenditures for the US noninstitutionalized civilian population. The MEPS is a 2-year panel survey, with an overlapping cohort design, taken from the National Health Interview Survey cohort. Each year, a new cohort is initiated and followed longitudinally through a series of 5 in-person interviews at 6-month intervals. The MEPS conducts interviews with 1 or more persons per household, who report on health care utilization, expenditures, insurance coverage, and medical conditions for each household member. Cross-sectional analyses combine information from 2 MEPS cohorts.

In 2000, the MEPS initiated a self-administered questionnaire (SAQ) to obtain information that potentially would be unreliable if reported by a proxy. The SAQ was distributed to all adults aged 18 years old or older in eligible households participating in the MEPS. In 2001, the questionnaire included both the SF-12 version 1 and the EQ-5D instruments.

The NHIS is a nationally representative survey of the US noninstitutionalized civilian population. Sampling and interviewing are continuous throughout each year with oversampling of both black persons and Hispanic persons. The NHIS is a cross-sectional household survey that gathers information on all household members and detailed information about 1 household adult and child. All information is collected by an interviewer. The detailed information includes health status information used in this analysis.

In these analyses, we used all respondents aged 20 or older from the surveys. This included 22,523 subjects from the MEPS 2001 and 32,472 subjects from the NHIS 2001.

Categorical Self-Rated Health—Self-Administered

Categorical self-rated health was indicated by the first question of the SF-12: "In general, would you say your health is: Excellent, Very good, Good, Fair,

The funding agreements ensured the authors' independence in designing the study, interpreting the data, writing, and publishing the report. The impetus for calculating these national values was the case study work of the Institute of Medicine (IOM) Committee to Evaluate Measures of Health Benefits for Environmental, Health, and Safety Regulation in collaboration with federal regulatory and health agencies. The collaborating agencies include AHRQ, Centers for Disease Control and Prevention, Food and Drug Administration, Environmental Protection Agency, and the National Center for Statistics and Analysis (NHTSA). Revision accepted for publication 20 March 2006.

Address correspondence and reprint requests to Janel Hanmer, Department of Population Health Sciences, University of Wisconsin-Madison, 644 WARF, 610 Walnut St., Madison, WI 53726; telephone: (608) 265-3298; fax: (608) 263-2820; e-mail: jehanmer@wisc.edu.

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or Poor?” We report the full distribution of responses to this question.

EQ-5D with UK Scoring—Self-Administered

The EuroQol EQ-5D has 5 multiple-choice questions that form a descriptive system with 5 dimensions concerning the respondent's health today: mobility, self-care, usual activities, pain, and anxiety/depression.²¹ Each question has 3 possible responses: no problems, some problems, or extreme problems/unable to. The pattern of responses for an individual can be converted to a single summary score by applying weights from a population-based valuation set, yielding a utility-based score. We used a time tradeoff valuation set derived from a sample representative of the United Kingdom for these UK scores.¹⁶ These weights allow for “states worse than death,” which are given negative values.

EQ-5D with US Scoring—Self-Administered

The EQ-5D with US scoring is based on the same questionnaire as the UK scoring but uses time tradeoff weights recently collected from a nationally representative sample in the United States.¹⁵ These weights also allow for “states worse than death,” which are given negative values.

Mental Component Summary and Physical Component Summary—Self-Administered

The 12 multiple-choice items of the SF-12 relate to 8 dimensions: physical functioning, physical role limitations, emotional role limitations, pain, general health, vitality, social functioning, and mental health. The SF-12 is an abridged version of the SF-36, which was constructed to reflect the mental and physical component summary scores of the parent scale.^{17,18} The MCS and PCS were developed from a reduction of the 8 dimensions to two dimensions by factor analysis. The factor scores were normalized so that both the mental component summary (MCS) and physical component summary (PCS) have averages of 50 and standard deviations of 10 with respect to the proprietary US national data set held by QualityMetric, Inc.¹⁸ We include imputed scores, calculated using a proprietary algorithm of QualityMetric, Inc.

SF-6D—Self-Administered

The SF-6D scoring algorithm uses 7 of the questions from the SF-12. These questions were used to

construct health scenarios that were evaluated using the standard gamble technique in a representative sample of the UK population. Regression analysis was then used to model the preferences assigned to each health state. With the resulting scoring algorithm, a utility-based score can be assigned to each health state.¹⁹

Visual Analog Scale from the EQ-5D—Self-Administered

The full EuroQol instrument includes the 5 multiple-choice items mentioned above and a visual analog scale. This 20-cm vertical scale runs from the “worst imaginable health state” at 0 to the “best imaginable health state” at 100. A subject places a mark to indicate “how good or bad [his or her] health is today,” which is converted to an integer between 0 and 100.²¹

Quality of Well-being Scale (Estimated)—Interviewer Administered

The QWB Scale categorizes a respondent in mobility, physical activity, social activity, and symptom/problem scales. Preference weights for each function level were derived from 867 raters, and a scoring algorithm was developed to yield scores between 0 and 1.²²

The QWB Scale was not administered in the 2001 MEPS, but a QWB estimation procedure has been developed from 1979 to 1996 NHIS data. Details of the imputation methodology are given elsewhere.^{12,20} QWB-estimates (QWBX1) were estimated using 2001 NHIS data, and the estimate algorithm was modified for the reorganized NHIS. Specifically, the 1997 and later NHIS had questions on functional limitations that more closely match with the QWB Social Activity and Physical Activity subscales. The analysis of these data was weighted to take into account the NHIS sampling design. The 2001 QWB data nonresponse was generally less than 1%. This is because the NHIS, like the interviewer-administered QWB Scale, employs patterns of questions and follow-up probes that allow pursuit of health classification information to near-definitive conclusions in nearly all cases.

Analyses

Data were analyzed using STATA (version 8.2, StataCorp, College Station, TX) to allow adjustment for the complex sampling design of the MEPS or the NHIS. The reported results incorporate the sampling and post-stratification weights, yielding nationally representative estimates for noninstitutionalized adults answering

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Table 1 Unweighted Age- and Sex-Stratified Counts of Respondents for Each Health-Related Quality-of-Life Measure

Males, <i>n</i> (%)							
Age Group	Total MEPS	Completed EQ-5D	Completed SF-12	Completed EQ-VAS	Completed Categorical	Total NHIS	QWB Computed
20–29	2087	1663 (80)	1664 (80)	1585 (76)	1662 (80)	2587	2574 (99)
30–39	2221	1912 (86)	1922 (86)	1856 (83)	1918 (86)	3102	3086 (99)
40–49	2276	2002 (88)	2021 (89)	1964 (86)	2021 (89)	3003	2986 (99)
50–59	1772	1545 (87)	1563 (88)	1521 (86)	1565 (88)	2321	2312 (100)
60–69	1070	962 (90)	976 (91)	959 (90)	975 (91)	1434	1423 (99)
70–79	781	704 (90)	715 (92)	702 (90)	716 (92)	1127	1120 (99)
80–89	305	263 (86)	266 (87)	260 (85)	267 (88)	515	515 (100)
Total	10,512	9051(86)	9127 (87)	8847 (84)	9124 (87)	14,089	14,016 (99)

Females, <i>n</i> (%)							
Age Group	Total MEPS	Completed EQ-5D	Completed SF-12	Completed EQ-VAS	Completed Categorical	Total NHIS	QWB Computed
20–29	2225	1881 (85)	1907 (86)	1800 (81)	1907 (86)	3202	3182 (99)
30–39	2456	2177 (89)	2203 (90)	2102 (86)	2209 (94)	3810	3794 (100)
40–49	2550	2277 (89)	2307 (90)	2205 (86)	2300 (90)	3708	3697 (100)
50–59	1910	1712 (90)	1743 (91)	1709 (89)	1744 (91)	2771	2756 (99)
60–69	1261	1145 (91)	1167 (93)	1145 (91)	1171 (93)	2025	2010 (99)
70–79	1005	887 (88)	899 (89)	881 (88)	914 (91)	1794	1782 (99)
80–89	604	499 (83)	500 (83)	491 (81)	519 (86)	1073	1073 (100)
Total	12,011	10,578 (88)	10,726 (89)	10,333 (86)	10,764 (88)	18,383	18,294 (99)

Note: MEPS, Medical Expenditures Panel Survey; EQ-5D, EuroQol-5D; EQ-VAS, EuroQol Visual Analog Scale; NHIS, National Health Interview Survey; QWB, Quality of Well-being Scale.

questionnaires. We use all respondents aged 20 or older. For categorical self-rated health, we report the full distribution of responses, stratified by sex and age by decade. For each continuous scale, we report the estimated mean value and 95% confidence interval around this estimate, stratified by sex and age by decade. We also report the quartile point estimates for each continuous scale, stratified by sex and age by decade.

RESULTS

The total number of respondents in each sample, as well as the number of respondents for each HRQoL measure, is presented by age and sex in Table 1. These counts represent total respondents, not the effective sample size after weighting. In general, instrument completion rates were very high; most age and sex categories had completion rates above 85%. Completion rates do vary with age and sex. For females, the highest rates of completion occur in the 60- to 69-year-old age bracket, with those aged 80 to 89 having the lowest completion rates. For males, the highest completion rates occur in the 70- to 79-year-old age bracket,

with those aged 20 to 29 having the lowest completion rates. The group with the lowest completion rates overall was 20- to 29-year-old males, of whom only 75.9% completed the EQ-VAS. The EQ-VAS was the least completed measure, with 3 groups having response rates under 85%: 20- to 29-year-old females at 80.9%, 30- to 39-year-old males at 83.6%, and 80- to 89-year-old females at 81.3%. The group with the highest completion rates was 60- to 69-year-old females, who had completion rates over 90% for each measure. In general, nonresponders had lower income, were less likely to have finished high school, were less likely to be married, were less likely to be white, and were more likely to be Hispanic than responders (data not shown).

The full distribution of categorical self-rated health responses, stratified by age and sex, is presented in Table 2. These values take the sampling weights into account. From this table, we can see that females are less likely to report “excellent” health than males, except in the oldest age groups. Among both males and females, older age groups are less likely to report “excellent” or “very good” health and more likely to

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Table 2 Age- and Sex-Stratified Distribution of Responses for Categorical Self-Rated Health

Age Group	Males					Females				
	E	V	G	F	P	E	V	G	F	P
20–29	.276	.427	.240	.054	.004	.218	.441	.263	.071	.006
30–39	.231	.437	.267	.057	.009	.193	.425	.291	.073	.018
40–49	.193	.390	.307	.091	.019	.145	.407	.308	.113	.028
50–59	.169	.358	.319	.118	.036	.140	.360	.339	.122	.039
60–69	.112	.331	.339	.164	.054	.090	.315	.375	.176	.044
70–79	.060	.255	.391	.224	.071	.065	.237	.397	.248	.055
80–89	.048	.218	.407	.262	.066	.054	.181	.375	.296	.094

Note: E, excellent; V, very good; G, good; F, fair; P, poor. Sampling weights are taken into account.

report “good,” “fair,” or “poor” health than the younger age groups.

The mean estimates and 95% confidence intervals, stratified by age and sex, and incorporating sampling weights for each continuous HRQoL score are presented in Table 3. These values take the sampling weights into account. Respondents report lower scores at higher ages except for the MCS score, which seems to slightly increase for those ages 60 to 79. Females report lower scores than males in all age groups and on all scores. The confidence intervals for these estimates are small because of the large number of respondents in the MEPS survey, although confidence intervals for means widen at older ages, where there were fewer respondents.

The mean estimates of the EQ-5D with UK scoring, EQ-5D with US scoring, EQ-VAS, QWB Scale, and SF-6D are plotted in Figure 1. EQ-VAS scores were rescaled between 0 and 1 for comparison. We did not include the MCS and PCS in this figure because they are not single summary scores of health.

Figure 1 shows that females report lower scores than males and that older respondents report lower scores within each measure. Although the trend with age is the same for each scoring system, the slope of change is not the same, so the rank order of scoring systems within an age range depends on the age range. Although the EQ-5D with US scoring, QWB Scale, and EQ-VAS appear to have similar slopes across the age groups, it appears that the SF-6D changes less with age and the EQ-5D with UK scoring changes more with age.

The point estimates for the quartiles of each continuous HRQoL measure, stratified by age and sex, are presented in Table 4. Quartiles were computed accounting for sampling weights. From this table, we can see the range of values for each summary score as well as the presence of ceiling effects. The most

prominent ceiling effects occur in the EQ-5D based instruments, with both the UK and US scoring, where more than 50% of the youngest age groups are given scores of perfect health (1.0). In general, the UK scoring gives lower values to each quartile than the US scoring.

DISCUSSION

In this report, we have presented nationally representative US values for a variety of HRQoL summary scores. These values were computed from large, recent, nationally representative surveys of the US noninstitutionalized civilian population. Previously, there has not been a publicly published set of nationally representative US values for any HRQoL score using an off-the-shelf instrument except for the SF-36 version 1, an estimated QWB, the EQ-5D with US scoring, and the HUI 2/3. (However, averages were reported for the “HALex” measure derived post hoc from the National Health Interview Survey.²³) To compare our findings to the privately published SF-12 values, we recomputed means with comparable age groups (data not shown) and found our estimates to be within ± 2 of the published PCS means and within ± 3 of the published MCS means.

We also compared our EQ-5D estimates to estimates from the data used in the recent paper by Luo and others¹² (data not shown) and found that the 95% confidence intervals from the estimated means overlapped in all sex and age groups. Use of either set of estimates would be appropriate for US averages, where we report averages of sex by age group; Luo and others report averages of race/ethnicity by other demographic variables. This MEPS sample may be more desirable because of its larger sample size, although details about the mode of administration may also determine the most appropriate data

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Table 3 Age- and Sex-Stratified Mean and 95% Confidence Interval (CI) for Each Continuous Health-Related Quality-of-Life Summary Score

Measure	Age Group	Male			Female		
		Lower 95% CI	Mean	Upper 95% CI	Lower 95% CI	Mean	Upper 95% CI
EQ-5D UK	20–29	0.902	0.910	0.919	0.882	0.892	0.902
	30–39	0.888	0.897	0.906	0.854	0.864	0.874
	40–49	0.844	0.854	0.864	0.808	0.820	0.832
	50–59	0.804	0.816	0.829	0.772	0.785	0.797
	60–69	0.768	0.786	0.804	0.731	0.747	0.763
	70–79	0.716	0.736	0.756	0.670	0.689	0.708
EQ-5D US	80–89	0.675	0.711	0.747	0.589	0.622	0.656
	20–29	0.922	0.928	0.934	0.905	0.913	0.920
	30–39	0.912	0.918	0.925	0.886	0.893	0.900
	40–49	0.880	0.887	0.894	0.855	0.863	0.871
	50–59	0.853	0.861	0.870	0.829	0.837	0.846
	60–69	0.827	0.840	0.852	0.800	0.811	0.822
MCS (SF-12)	70–79	0.788	0.802	0.816	0.758	0.771	0.784
	80–89	0.757	0.782	0.807	0.701	0.724	0.747
	20–29	51.7	52.1	52.6	49.0	49.5	50.1
	30–39	51.5	52.0	52.4	49.2	49.7	50.2
	40–49	50.9	51.4	51.9	49.2	49.7	50.1
	50–59	51.7	52.1	52.6	49.9	50.4	50.9
PCS (SF-12)	60–69	52.1	52.7	53.3	51.2	51.8	52.3
	70–79	51.9	52.7	53.6	51.0	51.8	52.5
	80–89	50.2	51.5	52.7	49.4	50.4	51.3
	20–29	53.5	53.8	54.2	52.7	53.0	53.3
	30–39	52.6	53.0	53.3	51.2	51.6	52.1
	40–49	50.5	50.9	51.3	49.0	49.5	50.0
QWB Scale ^a	50–59	48.1	48.6	49.2	46.3	46.8	47.4
	60–69	44.7	45.6	46.4	43.2	44.0	44.7
	70–79	40.1	41.1	42.1	39.2	40.0	40.9
	80–89	37.2	38.7	40.2	34.9	36.0	37.1
	20–29	0.826	0.826	0.826	0.819	0.819	0.819
	30–39	0.831	0.831	0.831	0.820	0.820	0.820
SF-6D	40–49	0.803	0.803	0.803	0.797	0.797	0.797
	50–59	0.768	0.768	0.768	0.763	0.763	0.763
	60–69	0.737	0.737	0.737	0.738	0.738	0.738
	70–79	0.724	0.724	0.724	0.718	0.718	0.718
	80–89	0.662	0.662	0.662	0.645	0.645	0.645
	20–29	0.851	0.857	0.862	0.822	0.827	0.833
EQ-VAS	30–39	0.843	0.849	0.855	0.812	0.818	0.824
	40–49	0.825	0.831	0.836	0.798	0.804	0.810
	50–59	0.811	0.819	0.827	0.781	0.788	0.795
	60–69	0.793	0.803	0.813	0.775	0.784	0.794
	70–79	0.758	0.770	0.783	0.736	0.748	0.759
	80–89	0.723	0.742	0.761	0.684	0.700	0.716
EQ-VAS	20–29	86.4	87.2	88.0	83.7	84.5	85.2
	30–39	84.2	84.9	85.6	81.0	81.8	82.5
	40–49	81.2	81.9	82.7	79.4	80.3	81.1
	50–59	78.4	79.5	80.6	77.6	78.5	79.4
	60–69	75.4	76.9	78.3	75.1	76.3	77.5
	70–79	71.6	72.8	74.4	71.2	72.6	74.1
EQ-VAS	80–89	67.7	70.2	72.7	64.1	66.1	68.1

Note: EQ-5D UK, EuroQol-5D with UK scoring; EQ-5D US, EuroQol-5D with US scoring; MCS, mental component summary from the SF-12; PCS, physical component summary from the SF-12; QWB, Quality of Well-being Scale; EQ-VAS, Visual Analog Scale from the EuroQol instrument.

a. The upper and lower bounds on the confidence interval (CI) for the QWB estimates differ only in the fourth significant figure.

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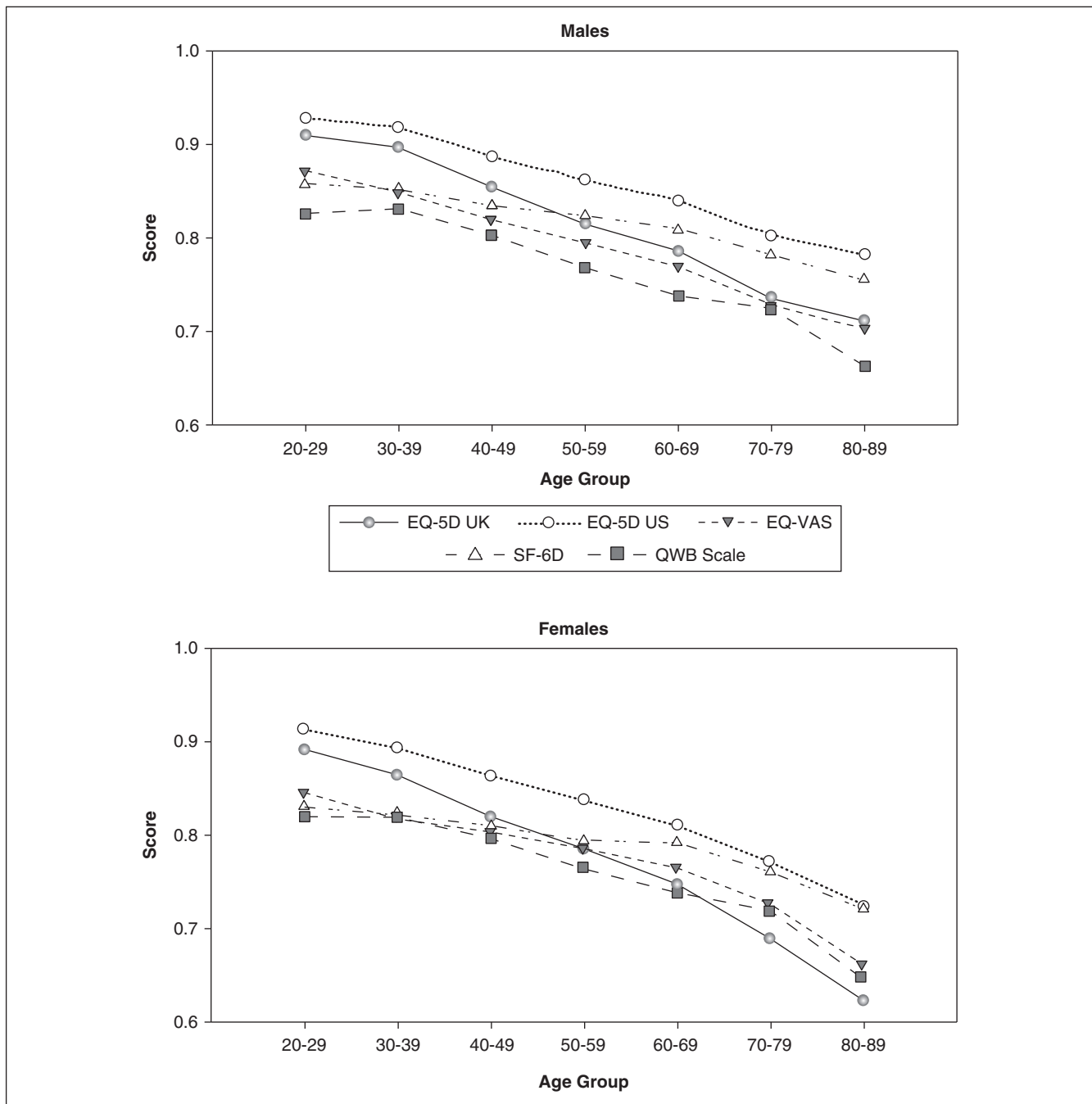


Figure 1 Age- and sex-stratified means for the EQ-5D UK, EQ-5D US, QWB Scale, SF-6D, and EQ-VAS. "EQ-5D UK" is the EuroQol-5D with UK scoring, "EQ-5D US" is the EuroQol-5D with US scoring, QWB is the Quality of Well-being Scale, and "EQ-VAS" is the Visual Analog Scale from the EuroQol instrument.

set to use for future comparisons; the EQ-5D was self-completed on paper for both surveys, the MEPS was a mailed questionnaire, and the questionnaire used by Luo and others was completed while an interviewer was present.

Table 3 shows that, as expected, females report lower mean scores than males and older respondents generally report lower scores within each measure. There are 2 exceptions to the age trend. The first is an increase in estimated QWB scores from the

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Table 4 Age- and Sex-Stratified Quartile for Each Continuous Health-Related Quality-of-Life Summary Score

Measure	Age Group	Males					Females				
		Min	25%	50%	75%	Max	Min	25%	50%	75%	Max
EQ-5D UK	20–29	–0.239	0.848	1	1	1	–0.594	0.796	1	1	1
	30–39	–0.484	0.796	1	1	1	–0.536	0.796	1	1	1
	40–49	–0.484	0.796	1	1	1	–0.484	0.725	0.848	1	1
	50–59	–0.239	0.727	0.796	1	1	–0.484	0.725	0.796	1	1
	60–69	–0.594	0.691	0.796	1	1	–0.594	0.691	0.796	1	1
	70–79	–0.594	0.691	0.796	0.883	1	–0.594	0.620	0.725	0.848	1
	80–89	–0.184	0.620	0.760	0.850	1	–0.594	0.516	0.691	0.796	1
EQ-5D US	20–29	0.122	0.844	1	1	1	–0.109	0.827	1	1	1
	30–39	–0.040	0.827	1	1	1	–0.100	0.827	1	1	1
	40–49	–0.038	0.827	1	1	1	–0.040	0.800	0.844	1	1
	50–59	0.063	0.810	0.827	1	1	–0.038	0.800	0.827	1	1
	60–69	–0.109	0.778	0.827	1	1	–0.109	0.778	0.827	1	1
	70–79	–0.109	0.778	0.827	0.860	1	–0.109	0.707	0.800	0.843	1
	80–89	0.118	0.708	0.816	0.853	1	–0.109	0.597	0.778	0.827	1
MCS (SF-12)	20–29	13.1	49.1	55.1	57.8	69.2	9.5	45.1	53.0	56.3	67.6
	30–39	12.9	49.0	54.6	57.8	70.6	8.6	45.6	53.0	56.7	70.5
	40–49	13.9	47.6	54.3	57.8	68.8	14.7	44.8	53.0	56.8	68.5
	50–59	12.9	49.0	55.1	57.9	67.0	15.5	46.1	53.6	57.4	67.7
	60–69	17.0	49.1	55.7	58.7	68.5	16.7	47.2	55.0	58.5	69.0
	70–79	13.7	48.8	55.8	59.7	71.4	19.1	45.6	54.9	58.9	71.3
	80–89	19.0	45.4	54.6	58.7	67.4	12.8	42.1	52.4	58.9	69.0
PCS (SF-12)	20–29	21.1	52.9	55.5	56.8	66.4	17.6	51.2	55.3	56.8	66.3
	30–39	14.2	51.8	55.5	56.7	65.4	12.3	49.7	54.8	56.6	68.0
	40–49	11.9	48.3	53.8	56.3	67.1	14.3	45.7	53.2	56.1	66.3
	50–59	16.4	45.2	52.4	55.8	65.3	13.2	39.2	51.1	55.5	65.6
	60–69	14.5	37.1	49.8	54.8	68.8	14.6	35.1	47.1	53.8	64.5
	70–79	12.5	31.9	42.5	51.7	64.5	11.2	30.2	40.2	51.7	63.1
	80–89	16.7	29.7	37.9	48.9	60.2	12.3	26.2	34.0	46.4	58.9
QWB Scale	20–29	0.460	0.743	0.814	1	1	0.451	0.741	0.814	1	1
	30–39	0.422	0.743	0.814	1	1	0.439	0.741	0.814	1	1
	40–49	0.394	0.701	0.796	0.856	1	0.394	0.701	0.770	0.856	1
	50–59	0.378	0.701	0.770	0.830	1	0.378	0.701	0.770	0.856	1
	60–69	0.378	0.660	0.743	0.830	1	0.394	0.660	0.756	0.830	1
	70–79	0.378	0.640	0.718	0.830	1	0.378	0.606	0.735	0.830	1
	80–89	0.378	0.563	0.667	0.743	1	0.378	0.518	0.640	0.743	1
SF-6D	20–29	0.345	0.800	0.863	0.922	1	0.373	0.793	0.863	0.863	1
	30–39	0.345	0.800	0.863	0.922	1	0.345	0.755	0.863	0.880	1
	40–49	0.345	0.797	0.863	0.922	1	0.345	0.737	0.863	0.863	1
	50–59	0.345	0.782	0.863	0.922	1	0.345	0.723	0.821	0.863	1
	60–69	0.345	0.734	0.863	0.922	1	0.345	0.695	0.817	0.863	1
	70–79	0.345	0.660	0.800	0.880	1	0.345	0.618	0.758	0.863	1
	80–89	0.366	0.618	0.754	0.863	1	0.357	0.561	0.695	0.859	1
EQ-VAS	20–29	0	80	90	95	100	0	80	89	95	100
	30–39	0	80	90	95	100	0	75	85	91	100
	40–49	0	75	85	92	100	0	75	85	90	100
	50–59	0	75	85	90	100	0	70	85	90	100
	60–69	0	70	80	90	100	0	66	80	90	100
	70–79	0	60	80	89	100	0	60	78	88	100
	80–89	0	60	75	85	100	0	50	70	80	100

Note: EQ-5D UK, EuroQol-5D with UK scoring; EQ-5D US, EuroQol-5D with US scoring; MCS, mental component summary from the SF-12; PCS, physical component summary from the SF-12; QWB, Quality of Well-being Scale; EQ-VAS, Visual Analog Scale from the EuroQol instrument.

US POPULATION NORMS FOR 7 HRQoL SCORES

20- to 29-year-old age group to the 30- to 39-year-old age group. This increase is very small (.005 for males and .001 for females) and may be noise from a loss of discrimination in the QWB estimation procedure; before 1997, the NHIS reported 300 diseases/conditions in Recode B, plus another 133 in condition lists. By contrast, the 2001 NHIS reported 61 conditions. The second exception is that MCS scores peak in the 60- to 69-year-old and 70- to 79-year-old age groups. This increase appears to be real as a similar increase is reported in the privately published SF-12 values, with a peak in the 65- to 75-year-old age group.¹³

The values for preference-based scores can be used as a basis for judging incremental effects in cost-effectiveness analyses, whereas the values for the other scores can be used for descriptive comparisons of health status. For analysts intending to use values reported here for cost-effectiveness analyses, it is important to note that none of the measures has a mean of perfect health (1.0) in any stratum; an analysis should not assume that preventing or curing a condition will return a person to perfect health.²⁴ It is also important to note that the values for any age and sex stratum vary by summary score, and mixing absolute values across scoring systems could lead to different conclusions than using the same scoring system consistently for all valuation within 1 analysis. For instance, comparing the mean EQ-5D US score for a 60- to 69-year-old to the mean SF-6D score for a 40- to 49-year-old would lead—erroneously—to the conclusion that those aged 60 to 69 report better health than those aged 40 to 49. If these age brackets were compared using mean scores within either scoring system, the opposite—and correct—conclusion would be obtained.

The confidence intervals around the mean estimates by age and sex are small in this report because of the large number of respondents and generally high completion rates for each measure. In the MEPS, the measures in order from highest to lowest completion rates were the SF-12, EQ-5D, and EQ-VAS, which is the same order that these measures were placed in the questionnaire. Other recent, large population surveys administered by mail in the United States²⁵ and Canada,²⁶ which included the EQ-5D, EQ-VAS, and the SF-12, found lower response rates for the SF-12. The SF-12 appeared after the EQ-5D and EQ-VAS in the US questionnaire, suggesting that the differing completion rates may be dependent on placement within the questionnaire and not characteristics of the indexes. Unfortunately, the variability in completion rates in different measures means that the set of respondents

within each measure is different. Although 82% of respondents completed all measures in the MEPS, the reported values may be subject to a measure-by-measure self-selection bias.

A strength of using the MEPS data for this analysis is that the survey included 2 intact HRQoL instruments. From these 2 instruments, we directly determined 6 of the summary scores presented in this report. The seventh summary score, the QWB Scale, was estimated using a procedure developed from questions in the contemporaneous NHIS data.²⁰ It would have been preferable to have access to a nationally representative sample that directly answered the questions within the QWB Scale and other commonly used measures.

Although we have reported nationally representative means and quartiles for 3 of the most commonly used HRQoL measures, a variety of other off-the-shelf measures were not included. The most notable exclusion is the Health Utilities Index, although nationally representative mean estimates of this measure are publicly available.¹² If the MEPS continues to include HRQoL measures, this report should be updated periodically for convenient and timely use by analysts.

In conclusion, we have presented the first publicly available set of nationally representative US values for any standardized HRQoL measure, except those for the SF-36 version 1,¹⁰ the estimated QWB,¹¹ the EQ-5D with US scoring,¹² and the HUI 2/3.¹² We have presented these values for 7 different summary scores; 6 scores come directly from intact measures, and 1 was estimated. We believe nationally representative values are important for both generalized comparisons of health status and cost-effectiveness analyses.

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TEMPLATE

REQUEST FOR A RELIGIOUS EXCEPTION TO THE COVID-19 VACCINATION REQUIREMENT

Government-wide policy requires all Federal employees as defined in 5 U.S.C. § 2105 to be vaccinated against COVID-19, with exceptions only as required by law. In certain circumstances, Federal law may entitle a Federal employee who has a religious objection to the COVID-19 vaccination requirement to an exception from that requirement, in which case the employee would instead comply with alternative health and safety protocols. The Federal Government is committed to respecting the important legal protections for religious liberty.

In order to request a religious exception, please fill out this form. The purpose of this form is to start the accommodation process and help your agency determine whether you may be eligible for a religious exception. You do not need to answer every question on the form to be considered for a religious exception, but we encourage you to provide as much information as possible to enable the agency to evaluate your request. Where there is an objective basis to do so, the agency may ask you for additional information as needed to determine if you are legally entitled to an exception. Objections to COVID-19 vaccinations that are based on non-religious reasons, including personal preferences or non-religious concerns about the vaccine, do not qualify for a religious exception.

Agencies may consider several factors in assessing whether a request for an exception is based on a sincerely held religious belief, including whether the employee has acted in a manner inconsistent with their professed belief. But no one factor is determinative. An individual's beliefs—or degree of adherence—may change over time and, therefore, an employee's newly adopted or inconsistently observed practices may nevertheless be based on a sincerely held religious belief. All requests for a religious exception will be evaluated on an individual basis.

Signing this form constitutes a declaration that the information you provide is, to the best of your knowledge and ability, true and correct. Any intentional misrepresentation to the Federal Government may result in legal consequences, including termination or removal from Federal Service.

QUESTIONS:

1. Please describe the nature of your objection to the COVID-19 vaccination requirement.
2. Would complying with the COVID-19 vaccination requirement substantially burden your religious exercise or conflict with your sincerely held religious beliefs, practices, or observances? If so, please explain how.
3. Please provide any additional information that you think may be helpful in reviewing your request. For example:
 - How long you have held the religious belief underlying your objection
 - Whether your religious objection is to the use of all vaccines, COVID-19 vaccines, a specific type of COVID-19 vaccine, or some other subset of vaccines
 - Whether you have received vaccines as an adult against any other diseases (such as a flu vaccine or a tetanus vaccine)

I declare to the best of my knowledge and ability that the foregoing is true and correct.

 Print Name

 Signature

 Date

Insert Privacy Act Statement Here



Requiring influenza vaccination for health care workers: seven truths we must accept

Gregory A. Poland^{a,b,*}, Prithish Tosh^{a,b}, Robert M. Jacobson^{a,c}

^a Mayo Vaccine Research Group, 611 C Guggenheim Building, 200 First Street, SW, Mayo Clinic and Foundation, Rochester, MN 55905, USA

^b Program in Translational Immunovirology and Biodefense, Department of Medicine, Department of Pediatric and Adolescent Medicine, Mayo Clinic, Rochester, MN, USA

^c Department of Pediatric and Adolescent Medicine, Mayo Clinic, Rochester, MN, USA

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Abstract

In this paper we outline the seven primary truths supporting the call for requiring influenza immunization of all health care workers. We view this as a serious patient safety issue, given the clear and compelling data regarding the frequency and severity of influenza infection. In addition, clear-cut safety, efficacy, economic, legal, and ethical platforms support the use of influenza vaccine. Unfortunately health care workers have demonstrated, over almost 25 years that they are unwilling to comply with voluntary influenza immunization programs utilizing a variety of education and incentive programs, at rates sufficient to protect the patients in their care. We suggest that an annual influenza immunization should be required for every health care worker with direct patient contact, unless a medical contraindication or religious objection exists, or an informed declination is signed by the health care worker. High rates of health care worker immunization will benefit patients, health care workers, their families and employers, and the communities within which they work and live.

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1. Introduction

Influenza causes worldwide yearly epidemics resulting in 250,000–500,000 deaths [1]. The most efficient method of preventing these annual outbreaks and resulting morbidity and mortality is by the use of pre-exposure immunization. Because those most vulnerable to the complications of influenza, including death, congregate around health care workers by virtue of attending clinics, hospitals, and offices, an important method to decrease exposure to those most vulnerable is to immunize health care workers. The Centers for Disease Control and Prevention (CDC) has recommended influenza vaccination for all health care workers since 1981. Since that time, health care organizations across the country have established voluntary programs to provide influenza vaccine to health care workers in order to protect the lives and health

of their patients. The response thus far has been dismal, as only 36% of US health care workers received influenza vaccination in 2002 [2]. Even among health care centers utilizing highly organized and aggressive campaigns to promote immunization of health care workers, 30–50% remain unvaccinated. After more than two decades of voluntary trial and error programs, the time has come to take the next step in addressing this public health challenge by requiring influenza immunization of all health care workers. Here, we provide the data and rationale for such a requirement. We suggest that an annual influenza vaccine should be required for every health care worker with direct patient care activities, unless a medical contraindication to influenza immunization exists, a religious objection to immunization exists, or an informed declination is signed by the health care worker. This is identical to the highly successful method utilized in the hepatitis B immunization requirement for health care workers.

Since the initial Centers for Disease Control and Prevention (CDC) recommendation, the scientific understanding of

* Corresponding author. Tel.: +1 507 284 4456; fax: +1 507 266 4187.
E-mail address: poland.gregory@mayo.edu (G.A. Poland).

influenza, the influenza vaccine, and the data on the efficacy of influenza immunization support the assertion that immunizing health care workers safely and effectively prevents a significant number of influenza infections, hospitalizations, and deaths among the patients they care for, as well as preventing workplace disruption and medical errors by workers absent from work due to illness, or present at work, but ill [3–7]. It is now undeniable that influenza vaccination of health care workers does result in improved patient safety, improved employee safety, and decreased health care expenditures [6,7]. In this paper, we provide the data for these assertions and put forward the proposal that the medical community has a moral imperative to take appropriate action to protect the vulnerable patients for whom they care, their fellow health care workers, and the public at large. With voluntary health care worker vaccination programs failing to achieve acceptable immunization rates [8], the data lead us to conclude that requiring influenza immunization of health care workers is a moral imperative. If the medical community is unable to overcome the inertia of the current policy that endangers the public, the medical community may lose control of the ability to make this choice.

We suggest that the medical, legislative, and public views of this health threat would likely be different if we were discussing a more exotic virus having the same transmissibility and morbidity as influenza. If we had a safe and effective vaccine against a newly emerging infection such as SARS or avian influenza, would we allow health care workers to care for infected patients without having received the vaccine? Conversely, would we allow infected health care workers to care for uninfected patients? In fact, concerns about the ethics of such behavior would surface almost immediately. Yet, we allow precisely these situations to occur with a virus that kills 36,000 Americans every year—the equivalent of a September 11, 2001 World Trade Center disaster every month of every year [9]. This is a horrific carnage that pales, however, to the 250,000–500,000 persons lost to this virus every year worldwide. Although we recognize that there are differing opinions regarding the appropriate policy regarding the issue of health care workers and influenza vaccine, we must acknowledge seven truths emerge from decades of research. Together they form a platform on which we can firmly stand and contend that we should require influenza vaccines for all health care workers.

2. The first truth: influenza infection is a serious illness causing significant morbidity and mortality adversely affecting the public health on an annual basis

Influenza is the sixth leading cause of death among adults in the United States, killing an average of 36,000 Americans annually [9]. Influenza kills as many or more Americans each year than breast cancer (40,000), and three times as many as HIV/AIDS (14,000) [9–11]. Influenza is related to 1 out of

every 20 deaths in the US among those older than 65 years of age. Overall, nearly 1 out of every 10,000 Americans will die of influenza and its complications this winter [2,12]. In addition, influenza causes enormous and unnecessary annual health care expenditures affecting the global economy. For example, the estimated annual direct cost of influenza infection in the United States is estimated to be between 3 and 5 billion dollars [13].

3. The second truth: influenza-infected health care workers can transmit this deadly virus to their vulnerable patients

Complications of nosocomial influenza are particularly burdensome on the elderly, the immunocompromised, critically ill patients, and young children—the very populations congregated in hospitals and medical clinics [2,9,14,15]. Influenza infection in these populations can often result in severe, prolonged, devastating illness, death, increased length of stay, and added costs [14,16]. The virus can be transmitted to patients and other employees by both symptomatic and asymptomatic health care workers—hence, simply “staying home from work” is an insufficient strategy for preventing nosocomial transmission [16,17]. Worse yet, multiple studies that have shown that health care workers continue to work despite being ill with influenza, increasing exposure of patients and coworkers [3,18,19]. Numerous reports of hospital influenza outbreaks exemplify the risk. In an influenza A, outbreak in a neonatal intensive care unit in 1998, 19 of the 54 patients on the ward tested positive for influenza A [20]. Of these 19, 6 were symptomatic and 1 died. In a survey of the 150 medical staff involved during the outbreak, only 15% had received the influenza vaccination including 67% of physicians and 9% of nurses. Only 29% of staff with symptomatic influenza took time off from work. Another outbreak the same year in another bone marrow transplant unit illustrates the devastation that a hospital outbreak can have on its most vulnerable patients. Of the 25 confirmed cases of nosocomial pneumonia in the hospital, 40% were in the BMT ward, 2 of which died [21]. Surveys during this outbreak revealed a 12% vaccination rate among health care workers on the unit. The following influenza season, despite of an aggressive eight-pronged, but voluntary education program, 42% of health care workers on the bone marrow transplant unit still failed to receive influenza vaccine.

Conversely, influenza immunization of health care workers protects vulnerable patients, improves patient safety, and can significantly decrease patient morbidity and mortality. A Scottish study compared mortality rates between long-term care hospitals that offered influenza vaccination to health care workers, where 51% were vaccinated, and hospitals that did not, where only 5% were vaccinated [7]. The result was nearly a 40% reduction in all-cause mortality among the patients cared for by the health care workers in the hospitals with higher levels of health care worker influenza vaccination. No

wonder that the National Quality Forum, a voluntary consensus health care standard-setting organization in the US, has listed influenza immunization of health care workers as 1 of 30 safe practices that should be used universally to reduce the risk of harm to patients [22].

4. The third truth: influenza vaccination of health care workers saves money for employees and employers and prevents workplace disruption

Nichol et al. [6] reported that healthy working adults who receive influenza vaccination have 25% fewer upper respiratory infections, 44% fewer doctor visits, and 43% fewer sick days off, saving an average of \$47 per person annually. A previous study by Nichol et al. [23] revealed that among three different cohorts of 25,000 adults each studied over 3 years, influenza vaccination reduced pneumonia and influenza hospitalizations by 48–57%, all acute and chronic respiratory conditions by 27–39%, and all cause mortality by 39–54%. This resulted in a direct savings per year averaging \$117 per person immunized [23].

With the majority of health care workers not receiving influenza vaccination, influenza epidemics frequently result in staffing problems in clinics and hospitals across the country. To assess the impact of influenza on acute care hospitals, the CDC conducted a web-based survey of hospital epidemiologists in 221 institutions from all regions in the US from December 2003 to February 2004 (unpublished data presented at the ACIP meeting, February 2004, Atlanta, GA). In this survey, 35% of hospitals reported staffing shortages during the peak influenza epidemic. Furthermore, 28% reported bed shortages, 43% reported ICU bed shortages, and 9% reported diversion of patients to other care facilities for a mean of 6 days. Although health care organizations have been concerned about the cost of vaccinating their employees, the costs of not doing so are much higher, and the end result is a net cost benefit and a safer environment for patients.

5. The fourth truth: influenza vaccination of health care workers is already recommended by the CDC and is the standard of care

This recommendation has been in place by the Centers for Disease Control and Prevention since 1981. Since that time, hospitals, clinics, and health organizations have developed influenza immunization programs and have devoted resources to it. However, these programs are passive, voluntary systems that fail to recognize the current data and realities [24]. The result is a failed and incomplete system reaching an average of only 36% of US health employees annually [2]. Voluntary health care worker influenza immunization, although improved over the last several decades, remains unacceptably low [8]. Voluntary immunization programs in the US have never resulted in high immunization rates for any age,

in any setting, for any disease, in any location, at any time, in any age group, for any reason. Voluntary immunization programs simply do not result in high and sustained levels of vaccine coverage. Because of the serious consequences related to nosocomial influenza outbreaks as well as the impact on health care workers and the economic impact on health care systems, it is an imperative that action be taken to improve health care worker vaccination rates. Voluntary programs have not succeeded in attaining acceptable immunization rates, and there is no reason to think they will do so in the near future. It is necessary to develop new programs or legislation requiring influenza vaccination for all health care workers.

6. The fifth truth: immunization requirements are effective and work in increasing vaccination rates

A requirement for vaccination is not unique to influenza. Childhood immunization rates vastly improved in the US, often exceeding 90–95%, once mandatory school-entry immunization requirements were put into place. In health care settings, mandating hepatitis B vaccination and rubella vaccination has also been successful in achieving nearly universal immunization of health employees against these pathogens. Similarly, health care worker requirements for measles, mumps, varicella, and annual screening for tuberculosis, have worked and result in improved patient safety. Although there is concern that an influenza immunization requirement would be met with resistance, other vaccine mandates have been widely accepted. We believe that requiring influenza vaccination for health care workers would similarly be highly effective and, perhaps with additional education, widely accepted.

7. The sixth truth: health care workers and health care systems have an ethical and moral duty to protect vulnerable patients from transmissible diseases

The Occupational Safety and Health Agency and the Joint Commission on Accreditation of Healthcare Organizations have supported the idea of protecting health care workers and the patients they care for by pursuing vaccination initiatives as well as other measures to protect all involved. Beyond government interventions, the medical community has an ethical obligation to act with the safety of its patients as its foremost interest. It is now known that health care workers are vectors for the spread of influenza to vulnerable patients whom the disease would most jeopardize. It is also known that influenza vaccination of health care workers protects patients from influenza infection and decreases mortality. Finally, the vaccine is safe. Knowing these facts and not acting upon them with a comprehensive, effective, expeditious, and reasonable manner is a dereliction of the responsibilities of the medical

community to the safety of the public whose care they are entrusted with.

8. The seventh truth: the health care system will either lead or be lambasted

Health organizations must take responsibility for curbing yearly epidemics that profoundly influence the health of our patients, our health care workers, our communities, and our global health. The US health care system has largely remained self-governing with regard to many health policies. With the recognition that voluntary health care worker immunization programs achieve only dismal vaccination rates among health care workers, the medical community should take decisive action. To make an influenza vaccination requirement a reality, health care organizations must set aside unfounded fears, preconceptions, and misconceptions about influenza, the influenza vaccine, and the response of health care workers to such a mandate. Clear and unambiguous data supporting the truths about influenza immunization render a vaccination requirement a necessity. If the medical community is unable to overcome the inertia of a policy that has been failing for decades, then the inevitable outcomes will be realized. Reports of nosocomial influenza outbreaks have already started to surface in the popular media, making the headlines of major newspapers last influenza season. As these reports become widely disseminated and as the public becomes aware that health care workers are largely unvaccinated, the health care system will lose trust and credibility. Once this is the case, the ability of the medical community to make its own policy decisions may be diminished, with the duty instead falling to enforcement organizations and legislative policy makers.

Some health organizations have already taken the initiative to protect the patients under their care. Virginia Mason Medical Center in Washington has recently instituted an influenza vaccination requirement for all its workers. In addition, seven US states including Alabama, Arkansas, Kentucky, Maine, Maryland, New Hampshire, Pennsylvania, and Rhode Island have enacted various influenza immunization mandates for health care workers in long-term care facilities and occasionally in acute care hospitals, allowing for appropriate exemptions [25–27]. The province of Ontario now mandates influenza immunization of all health care workers. But, we make it difficult for individual organizations and local governments by forcing piecemeal solutions. We need national and international initiatives and policies to make such a requirement a reality.

There are many financial, structural, and attitudinal obstacles that have been suggested as barriers to implementation of universal influenza immunization of health care workers. One concern is that doing so would be prohibitively expensive. But, after the initial costs of purchasing, advertising, and delivering the vaccine, health care systems would quickly realize the cost savings of decreased employee health care vis-

its, days of missed work due to illness, and decreased medical errors committed by ill employees [6]. Another concern is that influenza vaccination would be too difficult to implement every year. There are a variety of annual mandates for health care worker and patient safety programs such as tuberculosis exposure testing, medical licensure, infection control, and safety videos. An influenza vaccination requirement could be done in conjunction with these other requirements and would thus be unlikely to impose a significantly increased burden.

Some barriers would have to be overcome to implement an influenza vaccination requirement. For those with contraindications to the vaccine, a method of informed declination would be necessary. Even with a small percentage of individuals unable to be vaccinated, the phenomenon of herd immunity would continue to protect unimmunized health care workers and their patients. Employee resistance to an immunization mandate is an attitudinal barrier that would need to be overcome. Judging by the experience with other vaccine mandates, the extent of this would be minimal. Nonetheless, education campaigns regarding the need, the safety, and the efficacy of influenza vaccination would be valuable to further inform health employees of the reasons for the policy and to engage their cooperation. It is our prediction that in the years to come the medical profession will look back with chagrin that such a requirement was not put into place until well into the 21st century.

The medical community is now armed with clear and unambiguous data demonstrating that health care workers are vectors in nosocomial influenza outbreaks as well as data proving that influenza vaccination is safe, effective, cost efficient, and successful in reducing patient morbidity and mortality. The current policy of voluntary vaccination of health care workers is not effective in achieving acceptable immunization rates and thereby endangers the vulnerable patients we care for and are entrusted with. Requiring influenza vaccination of health care workers is the right thing to do. It benefits the patient, the employee, and the employer. The health profession has the opportunity to demonstrate that we can and will do the right thing for our patients and thereby reassert our national leadership role and engender trust and credibility among the public.

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Disclaimer: The views and opinions expressed herein are not necessarily the views and opinions of the Mayo Clinic, Department of Defense, The National Foundation for Infectious Diseases, The International Society for Vaccines, Center for Disease Control and Prevention, or any of the professional societies in which we are members. The views expressed are solely our own.

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CONCISE COMMUNICATION

Results of a National Survey of Infectious Diseases Specialists regarding Influenza Vaccination Programs for Healthcare Workers

Philip M. Polgreen, MD, MPH; Edward Septimus, MD; Thomas R. Talbot, MD, MPH; Susan E. Beekmann, RN, MPH; Charles Helms, MD, PhD

A minority of infectious diseases consultants currently work in healthcare institutions requiring influenza vaccination for healthcare workers, and in approximately half of these institutions, the healthcare workers who refuse vaccination do not face substantial consequences for their refusal. Although true mandatory policies are not common, a majority of infectious diseases consultants support such policies.

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The long-term failure of voluntary policies to increase rates of healthcare worker (HCW) influenza vaccination has stimulated a debate about mandatory HCW influenza vaccination programs.¹⁻⁵ Since 2004, an increasing number of hospitals and healthcare facilities have introduced mandatory vaccination programs.⁶⁻⁸ Some of these programs have resulted in vaccination coverage of more than 95%, but some mandatory policies have been challenged in court.⁹ The purpose of our study was to describe the opinions and experiences of infectious diseases consultants regarding requirements for HCW influenza vaccination and to gauge the degree to which mandatory policies have been implemented.

METHODS

The Infectious Diseases Society of America's Emerging Infections Network is a sentinel network of infectious diseases physicians (funded by the Centers for Disease Control and Prevention) who regularly engage in clinical activity and who volunteer to participate. The eligible study population consisted of all 1,326 members of the network. A 14-question survey¹⁰ was sent via e-mail link or via fax to eligible members in December 2009. Two e-mail reminders were sent to nonresponders. All members were asked to provide information about influenza vaccination policies at the primary institution where they see patients and about their level of involvement in the HCW influenza vaccination campaign at this facility. The survey also examined the implementation of mandatory HCW influenza vaccination programs, the use of signed declination forms for those refusing vaccination, details on types of exemptions to vaccination allowed by the facility, consequences for not following the program requirements, and details regarding vaccine avail-

ability. Attitudes regarding mandatory HCW influenza vaccination programs, public reporting of institutional HCW influenza vaccination rates, and the impact of vaccine shortages and the novel H1N1 influenza A (2009 H1N1) pandemic on the vaccination program were also assessed.

Data were analyzed by use of SAS, version 9.2 (SAS Institute). The χ^2 test or the Fisher exact test was used to compare proportions between categorical variables, as appropriate.

RESULTS

Of the 668 infectious diseases specialists who responded (50% response rate), 460 (68.9%) were involved in the influenza vaccination program at their institutions. The majority of respondents believe that influenza vaccination should be required for all HCWs (89% agree or strongly agree) and that HCWs refusing vaccination should be required to sign a declination statement (89% agree or strongly agree). Seventy-four percent agreed or strongly agreed that institutional HCW influenza vaccination rates should be reported publicly as a measure of patient safety.

Only 211 (37%) of 575 respondents reported that their healthcare institutions required influenza vaccination of HCWs. Of the 364 hospitals that did not require vaccination, the majority (186 [51%]) were either considering or attempting such a requirement. Of the 211 hospitals that required vaccination of HCWs, 193 (91%) allowed exceptions. Common exceptions in facilities requiring vaccination included medical contraindication (162 hospitals [84%]), religious beliefs (90 hospitals [47%]), and personal beliefs (71 hospitals [37%]). In addition, the consequences for refusing vaccination varied among hospitals (Table 1).

Of the 289 hospitals that required declination forms to be signed by HCWs refusing vaccination, the consequences for refusing to sign these forms were reported by 227 respondents: 123 (54%) reported no consequences; 49 (22%) were unsure that consequences existed; 20 (9%) reported job termination or stated that their facility did not allow HCWs to work until they signed the form; 7 (3%) required HCWs to get educated about influenza vaccination; 7 (3%) required HCWs to wear masks during patient care; and 4 (2%) reported that job evaluations were affected. Of the 211 hospitals that required vaccination, 34 (16%) did not provide free vaccination to their independent physicians, and 28 (13%) did not provide free vaccination to healthcare students. Of 575 healthcare institutions, 164 (29%) reported resistance to their respective vaccination programs from the following groups: administrators (10%), vaccination program personnel (5%), individual HCWs (76%), and HCW organizations (eg, unions [35%]).

TABLE 1. Data on Presence of Institutional Requirements for Influenza Vaccination of Healthcare Workers and Consequences for Refusing Vaccination, Collected from a Survey Sent to Infectious Diseases Specialists in December 2009

Survey data	No. (%) of hospitals (n = 575)
No institutional requirement present	364 (63)
Institutional requirement present	211 (37)
Consequences ^a	
None	15 (7)
Required to sign declination form	129 (63)
Required risk assessment	14 (7)
Required to wear mask during patient care	82 (40)
Required job reassignment	14 (7)
Required job termination	26 (13)

^a Answered by 205 of the 211 hospitals that reported an institutional requirement for influenza vaccination of healthcare workers. The total adds to more than 100%, because respondents could select all responses that apply.

Respondents were also asked about the level of seasonal vaccine shortage and associated disruptions of their hospital's vaccination campaign. They reported varying degrees of shortages (Table 2). Finally, in an open-text comment field, 99 respondents reported an increased demand for vaccine or improved rates of vaccination as a result of the 2009 H1N1 pandemic. Ten members reported increased compliance with seasonal influenza vaccination but poor compliance with 2009 H1N1 vaccination. Sixty-six members reported that vaccine shortages impeded their ability to vaccinate employees and to mandate vaccination. However, 27 members reported increased staff awareness and interest in influenza vaccination related to the 2009 H1N1 pandemic.

DISCUSSION

We found that a minority of infectious diseases consultants work in healthcare institutions that require influenza vaccination for HCWs. Even in institutions that require vaccination, approximately half reported no substantial consequences for HCWs who refused vaccination. Although true mandatory policies are not widespread, we found that a majority of infectious diseases consultants believe that influenza vaccination of all HCWs should be required and that HCWs should be required to sign a declination statement if they refuse vaccination.

In recent successful examples of mandatory HCW influenza vaccination policies, annual seasonal vaccination has been made a condition of employment with few exceptions allowed. Recently, the Hospital Corporation of America achieved a vaccination rate of more than 95% in a system composed of 163 hospitals, 112 outpatient centers, and 368 physician practices employing 140,599 HCWs.¹¹ Our report will most likely increase interest in mandatory HCW vacci-

nation programs. Indeed, the Infectious Diseases Society of America now formally recommends a mandatory approach to seasonal influenza vaccination for HCWs.

We found it interesting that, among the "mandatory" programs, only a minority had significant consequences for employees refusing vaccination. Indeed, a large majority of respondents reported that declination forms served as a "signature statement," simply noting the individual's intent to refuse vaccination. Yet, making vaccination a condition of employment has generated controversy and forced hospital administrators to reexamine priorities regarding patient safety and HCW autonomy. In some cases, HCW organizations have legally challenged mandates. Our results suggest that most resistance to mandatory programs was from individual HCWs or HCW organizations. Finally, a requirement for influenza vaccination was not significantly associated with the type of hospital (eg, university or community).

Our study has several limitations. Although our response rate was high and although the results represent physician responses from 47 states, our survey was not a population-based survey. Physicians whose healthcare institutions have mandated vaccination programs or are interested in mandating vaccination might have been more likely to respond, resulting in an overestimation of the frequency of such programs. We used the individual respondent as the unit of analysis and not the institution, so multiple respondents from a single institution could have biased our results. However, we estimate that these respondents represent 450 unique hospitals.

The inability to achieve desired vaccination coverage of HCWs through voluntary approaches and interventions, along with the recently reported successes of mandatory programs, has increased enthusiasm for mandatory approaches. In fact, a majority of the physicians in our survey responded that their hospitals considered or attempted influenza vaccination requirements for HCWs for the past influenza season. Our results confirm another recent report from a single center indicating general support for mandatory vaccination

TABLE 2. Data on Seasonal Vaccine Shortages and Associated Disruptions of Vaccination Campaigns, Collected from a Survey Sent to Infectious Diseases Specialists in December 2009

Survey data	Proportion (%) of respondents	
	Seasonal vaccine	H1N1 vaccine
Level of vaccine shortage		
None	145/573 (25)	54/565 (10)
Minor	220/573 (38)	130/565 (23)
Considerable	148/573 (26)	227/565 (40)
Very significant	60/573 (10)	154/565 (27)
Level of disruption to vaccine campaign ^a		
Major	93/208 (45)	224/381 (59)
Some or minor	110/208 (53)	145/381 (38)

^a As reported by respondents with considerable or very significant shortages of vaccine.

among HCWs.¹¹ However, given that the meaning of “mandatory” appears to have different interpretations in different institutions, the success of mandatory influenza vaccination programs may depend largely on the enforcement mechanisms implemented and the consequences for HCWs refusing influenza vaccination.

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From the Department of Internal Medicine, Carver College of Medicine (P.M.P., S.E.B., C.H.), and the Department of Epidemiology, College of Public Health (P.M.P.), University of Iowa, Iowa City, Iowa; the Infection Prevention and Epidemiology Clinical Services Group, Hospital Corporation of America (E.S.), and the Department of Medicine and Preventive Medicine, Vanderbilt University School of Medicine (T.R.T.), Nashville, Tennessee; and Texas A&M Health Science Center, College Station, Texas (E.S.).

Address reprint requests to Philip M. Polgreen, MD, MPH, Department of Internal Medicine, Carver College of Medicine, University of Iowa, 200 Hawkins Drive, Iowa City, IA 52242 (philip-polgreen@uiowa.edu).

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SHEA POSITION PAPER

Revised SHEA Position Paper: Influenza Vaccination of Healthcare Personnel

Thomas R. Talbot, MD, MPH; Hilary Babcock, MD, MPH; Arthur L. Caplan, PhD; Deborah Cotton, MD, MPH;
Lisa L. Maragakis, MD, MPH; Gregory A. Poland, MD; Edward J. Septimus, MD;
Michael L. Tapper, MD; David J. Weber, MD, MPH

EXECUTIVE SUMMARY

This document serves as an update and companion piece to the 2005 Society for Healthcare Epidemiology of America (SHEA) Position Paper entitled "Influenza Vaccination of Healthcare Workers and Vaccine Allocation for Healthcare Workers During Vaccine Shortages."¹ In large part, the discussion about the rationale for influenza vaccination of healthcare personnel (HCP), the strategies designed to improve influenza vaccination rates in this population, and the recommendations made in the 2005 paper still stand. This position paper notes new evidence released since publication of the 2005 paper and strengthens SHEA's position on the importance of influenza vaccination of HCP. This document does not discuss vaccine allocation during times of vaccine shortage, because the 2005 SHEA Position Paper¹ still serves as the Society's official statement on that issue.

SHEA views influenza vaccination of HCP as a *core patient and HCP safety practice* with which noncompliance should not be tolerated. It is the professional and ethical responsibility of HCP and the institutions within which they work to prevent the spread of infectious pathogens to their patients through evidence-based infection prevention practices, including influenza vaccination. *Therefore, for the safety of both patients and HCP, SHEA endorses a policy in which annual influenza vaccination is a condition of both initial and continued HCP employment and/or professional privileges.* The implementation of this policy should be part of a multifaceted, comprehensive influenza infection control program; it must have full, visible leadership support with the expectation for influenza vaccination fully and clearly communicated to all existing and applicant HCP; and it must have ample resources

and support to implement and to sustain the HCP vaccination program. This recommendation applies to all HCP working in all healthcare settings, regardless of whether the HCP have direct patient contact or whether the HCP are directly employed by the facility. It also applies to all students, volunteers, and contract workers. SHEA recommends that only exemptions due to recognized medical contraindications to influenza vaccination be considered.

BACKGROUND

The transmission of influenza in the healthcare setting is an underrecognized yet substantial safety concern that places patients, other staff, and HCP at risk. Preventing the spread of influenza involves initiation of a comprehensive infection control program designed to identify and to isolate infectious persons while using work practice controls to reduce the risk of influenza transmission. Rapid identification and isolation of patients suspected to have infection, adherence to hand hygiene and respiratory etiquette, source control by the masking of persons with influenza-like illness (ILI), patient cohorting, use of personal protective equipment, restriction of ill HCP from working in the facility and of ill visitors from visiting, and antiviral prophylaxis and treatment (when indicated) all play essential roles in the reduction of transmission of any healthcare-associated respiratory infection, including influenza. Unlike efforts to prevent transmission of other respiratory viruses, however, vaccination of both patients and their contacts is the cornerstone of efforts to prevent influenza transmission. Influenza vaccination is a highly effective tool to prevent laboratory-confirmed influenza infection, particularly in healthy adults during seasons in which

From the Departments of Medicine and Preventive Medicine, Vanderbilt University School of Medicine (T.R.T.), and Hospital Corporation of America (E.J.S.), Nashville, Tennessee; Department of Internal Medicine, Washington University School of Medicine, St Louis, Missouri (H.B.); Department of Medical Ethics, University of Pennsylvania, Philadelphia (A.L.C.); Department of Medicine, Boston University School of Medicine (D.C.), and the Department of Epidemiology, Boston University School of Public Health (D.C.), Boston, Massachusetts; Department of Medicine, Johns Hopkins University School of Medicine, Baltimore, Maryland (L.L.M.); Department of Medicine, Mayo Clinic College of Medicine, Rochester, Minnesota (G.A.P.); Texas A & M Health Science Center, Houston (E.J.S.); Lenox Hill Hospital and the New York University School of Medicine, New York (M.L.T.); and the Departments of Medicine and Pediatrics, University of North Carolina at Chapel Hill (D.J.W.). D.C. and G.A.P. are liaisons from the Infectious Diseases Society of America.

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there is a close match between the vaccine and the circulating strains. A mismatch between the vaccine and the circulating wild-type strains is infrequent, but even in years with a substantial mismatch, the vaccine still may be partially effective. For example, data from the 2007–2008 influenza season showed that, even when 2 of the 3 vaccine strains were sub-optimally matched to circulating strains, vaccine effectiveness was substantial.² Influenza vaccination of patients is an important strategy in preventing influenza transmission, and a study in 301 long-term care facilities noted that high rates of *both* HCP and patient vaccination were significant predictors of reduced nosocomial influenza outbreaks.³ However, the protection provided by vaccination is reduced in certain populations (eg, young children, immunosuppressed persons, and older adults), which compose a large percentage of the patient population encountered in most healthcare settings. Thus, vaccination of HCP, who are usually healthy adults in whom vaccine immunogenicity, and hence efficacy, is highest, is essential to help reduce the transmission of influenza to the patients for whom they care.

Vaccination of HCP serves several purposes: (1) to prevent transmission to patients, including those with a lower likelihood of vaccination response themselves; (2) to reduce the risk that the HCP will become infected with influenza; (3) to create “herd immunity” that protects both HCP and patients who are unable to receive vaccine or unlikely to respond with a sufficient antibody response; (4) to maintain a critical societal workforce during disease outbreaks; and (5) to set an example concerning the importance of vaccination for every person. Importantly, modeling studies have estimated that in both acute care and long-term care settings, there is no HCP vaccination rate above which additional HCP vaccination coverage will not lead to further protection of patients.^{4,5} In these studies, vaccination of 100% of HCP in the acute care model resulted in a 43% reduction in the risk of influenza among hospitalized patients and a 60% risk reduction among nursing home patients. Several studies also have found influenza vaccination of HCP to be a cost-effective strategy to prevent patient morbidity.^{6,7}

Importantly, several studies now demonstrate that HCP influenza vaccination reduces patient mortality. In addition to the 2 studies^{8,9} noted in the 2005 SHEA position paper,¹ 2 subsequent cluster randomized trials have found that vaccination of HCP in a long-term care setting was significantly associated with reductions in patient mortality. The first study, performed in 44 facilities and involving more than 1,700 HCP and 2,600 residents, reported a significant decrease in patient mortality, ILI, ILI consultations with general practitioners, and ILI hospitalizations during a moderate influenza season among residents of homes in the HCP vaccination arm, compared with those residing in control facilities.¹⁰ These reductions were noted even in settings with high rates of resident vaccination (78.2% in the intervention homes vs 71.4% in the control facilities). Another study, conducted in France among 40 facilities that included 2,000 HCP and

nearly 3,500 residents, noted a significant reduction in the risk of all-cause patient mortality between the 2 study arms even after adjustment for resident age, resident vaccination status, resident disability score, and Charlson comorbidity index (odds ratio, 0.80 in intervention arm vs control arm).¹¹ Increased HCP vaccination rates also significantly correlated with reduced patient mortality rates.

This striking benefit for patients in long-term care facilities from vaccination of their HCP is remarkably consistent across all 4 studies. Some have argued that these studies do not provide evidence that vaccinating HCP against influenza protects elderly long-term care residents because the outcomes of noted benefit were nonspecific and were not laboratory-confirmed influenza.¹² Although each of these studies, like every study, has inherent limitations and biases, the consistency of impact of HCP vaccination across the 4 trials argues persuasively for the positive impact of influenza vaccination of HCP on reducing mortality of residents of extended care facilities. Some have claimed that the results from these studies may not apply to the acute care setting, calling for similar studies in each unique patient population. This stance, however, ignores several key points. First, performing a similar trial in the acute care setting would be exceedingly challenging and resource intensive, given the increased number of HCP-patient interactions, the shorter length of stay, and the difficulty of attributing influenza acquisition to healthcare-associated exposure. Second and more importantly, the biological rationale for vaccination of HCP to reduce influenza spread does not vary by practice setting. As noted in the 2005 SHEA Position Paper,¹ otherwise healthy adults (who presumably represent a large proportion of the HCP population) are infected routinely with influenza virus, with HCP likely to be at higher risk because of increased contact with infected patients seeking care. Infected HCP may shed virus before the development of clinical symptoms, in addition to shedding virus even when their symptoms are mild and not recognized as ILI. HCP have frequent direct contact with patients at high risk of morbid complications due to influenza, and yet HCP routinely report to work ill with respiratory symptoms.^{13,14} Finally, influenza vaccination has been shown in randomized controlled trials to reduce the incidence of laboratory-confirmed influenza infection in healthy adults.^{15,16} Thus, regardless of the specific practice setting, interventions that reduce acquisition of influenza will reduce influenza transmission. In addition, influenza vaccination has been shown to reduce HCP absenteeism,¹⁶ which also has potential patient safety benefits by reducing HCP-to-patient staffing ratios.^{17,18} Therefore, improving HCP influenza vaccination rates is a patient and HCP safety imperative.

Unfortunately, despite tremendous efforts to promote HCP influenza vaccination by government agencies, regulatory groups, professional societies, and visible vaccination champions, influenza vaccination rates among HCP remain unacceptably low. In a 2009 report by the Research and Development (RAND) Corporation, only 53% of surveyed HCP

reported receipt of influenza vaccination during the 2008–2009 influenza season.¹⁹ In addition in 2009, 39% of HCP stated they had no intention of getting vaccinated even with the heightened concern surrounding influenza with the novel H1N1 influenza A pandemic.²⁰ These data mirror findings from the National Health Interview Survey in which HCP influenza vaccination rates did not change significantly from the 2003–2004 influenza season (44.8%) through the 2007–2008 season (49.0%).²¹

IMPLEMENTATION OF POLICIES THAT REQUIRE INFLUENZA VACCINATION AS A CONDITION OF EMPLOYMENT

Since initial publication of the 2005 SHEA Position Paper,¹ and with continued frustration surrounding low and unimproved HCP vaccination rates, a move to the use of mandatory vaccination policies has occurred. Multiple hospitals and health-care systems now require influenza vaccination of HCP as a condition of employment. The first to implement such a policy was the Virginia Mason Medical Center (VMMC; Seattle, WA). In August 2004, prompted by suboptimal vaccination rates and their belief that voluntary programs were not an effective tool to boost vaccination coverage, VMMC leaders mandated influenza vaccination for all hospital personnel. This policy also included non-VMMC employees working at the medical center (eg, community physicians, vendors, students, and volunteers). Signed declinations for those without medical contraindications to the vaccine were not allowed. Despite notable initial resistance to the policy (discussed in further detail below), vaccination rates for the population of more than 5,000 VMMC employees and adjunct personnel have been sustained at greater than 98% in the 4 years since the program was implemented.^{22,23}

Similarly dissatisfied with an HCP vaccination rate of 71%, leaders at BJC Healthcare (St Louis, MO) made influenza vaccination a condition of employment before the 2008–2009 season.²⁴ Defined medical and religious exemptions were allowed. Encompassing nearly 26,000 employees at 11 acute care and 3 extended care facilities, BJC Healthcare achieved an impressive HCP influenza vaccination rate of 98.4%. Emphasizing the institutional commitment to this safety practice, there were 8 employees who were terminated for failure to meet conditions of employment.

During the 2009–2010 influenza season, the Hospital Corporation of America also implemented a mandatory vaccination policy for all of its 163 facilities throughout the United States. Differing from the VMMC and BJC Healthcare models, this model allowed personal belief exemptions along with medical and religious exemptions. The program was driven by visible leadership expectations centered on the message of patient safety. Hospital Corporation of America achieved a remarkable 96.4% vaccination rate among their more than 140,000 employees, of whom only 3.6% declined for any reason.²⁵ During that same season, the MedStar Health system of 9 hospitals in Maryland and the District of Columbia

achieved a vaccination rate of 98% among their approximately 26,000 employees and affiliated HCWs (including a 95% vaccination rate among affiliated physicians) after implementing a mandatory vaccination program (L. V. Karanfil, written communication, March 16, 2010).

These are but a few examples of healthcare facilities and systems that have moved successfully to a mandatory influenza vaccination policy. Other institutions and health systems, including the Hospital of the University of Pennsylvania (Philadelphia), Children's Hospital of Philadelphia (Philadelphia, PA), Emory University Hospital (Atlanta, GA), University of California Davis Health System (Sacramento, CA), Loyola University Health System (Maywood, IL), University Hospital (Cincinnati, OH), and multiple community hospitals, have established mandatory vaccination programs, and many others are strongly considering a similar policy for the 2010–2011 season. An up-to-date listing of health systems and healthcare facilities that require influenza vaccination for their HCP is provided by the Immunization Action Coalition.²⁶

In 2009 New York became the first state to require HCP influenza vaccination, issuing an emergency regulation that required influenza vaccination for all general hospital, home health, home care, and hospice HCP who had “direct contact with patients or whose activities are such that if they were infected with influenza, they could potentially expose patients, or others who have direct contact with patients, to influenza.”²⁷ Instituted in the midst of the 2009 novel H1N1 influenza A pandemic, the regulation was suspended for latter part of the 2009–2010 season because of issues related to vaccine availability. However, the State of New York Department of Health is drafting a permanent regulation regarding HCP influenza vaccination.²⁸

Studies of various HCP populations often have found that a majority of HCP accept the concept of mandatory influenza vaccination. A study among HCP at a tertiary children's hospital noted that 70% of respondents believed vaccination should be mandatory for HCP without a medical contraindication.²⁹ In another survey, 59.3% of inpatient nurses at the Mayo Clinic supported a policy that required influenza vaccination with exemptions allowed for medical and religious reasons or if the HCP provided a signed declination.³⁰ In this latter study, agreement with mandatory vaccination policies was strongly correlated with the length of time each policy had been in place—thus agreement with a mandatory hepatitis B virus vaccination policy was extremely high, with lower support for measles, mumps, and rubella (MMR) vaccination, lower yet for varicella vaccination, and lowest for influenza vaccination—reflecting the length of time each policy had been in place (G.A.P., written communication, 2010). A survey of academic physicians in the University of Pennsylvania Health System noted that 84.6% of respondents supported mandatory influenza vaccination of HCP.³¹ In a survey of SHEA members performed during the 2009–2010 pandemic influenza season, 78.2% of respondents agreed or strongly agreed with the statement “all healthcare workers

should be mandated to receive the flu vaccine or risk losing their jobs.”³²

Some have argued that mandatory influenza vaccination policies are coercive and negatively impact the employee-employer relationship.^{33,34} However, no data are available that support such a claim. Every healthcare institution already has multiple conditions of employment for HCP that are designed to reduce the risk of infectious disease transmission and to improve patient safety. Requirements for immunity to or vaccination against varicella, measles, mumps, and rubella are standard for most healthcare facilities. Those against vaccination mandates argue that influenza vaccination differs from these obligations, because of the annual requirement for vaccination and the invasiveness of the intervention. However, annual requirements for tuberculin skin testing, also an invasive intervention, are already commonplace at healthcare facilities. Furthermore, HCP are required to provide care to persons infected with potentially communicable diseases (eg, tuberculosis or HIV infection) even if that care (eg, surgery) entails a risk of disease acquisition.

Much discussion has occurred surrounding the ethics and legality of mandatory influenza vaccination programs for HCP.³⁵⁻⁴¹ Those against mandatory programs argue that the data supporting the impact of HCP influenza vaccination on patients are inconclusive, that voluntary programs have not been given enough time to have an impact or have not addressed attitudinal barriers to vaccination effectively, and that such policies may place patient protection above HCP autonomy and do not respect HCP autonomy. These practical and moral arguments are not persuasive.

Voluntary vaccination programs have been in place for decades with little evidence for an overall increase in HCP vaccination rates. Furthermore, multifaceted mandatory vaccination programs have been tried and tested and have been found to be the single most effective strategy to increase HCP vaccination rates, with multiple facilities and systems achieving vaccination coverage of more than 95%.⁴²

Those in support of mandatory programs argue that influenza vaccination is an ethical responsibility of HCP, because HCP have a duty to act in the best interests of their patients (beneficence), to not place their patients at undue risk of harm (nonmaleficence), and to protect the vulnerable and those at high risk of infection. The duty to put patient interests first is outlined in nearly every professional code of ethics in medicine, nursing, and other healthcare fields. Because the likelihood of a serious adverse reaction to influenza vaccine is extremely low, the duty to protect vulnerable patients and to put their interest above the personal interest of the healthcare worker does not demand undue sacrifice. Finally, the use of mandatory vaccination programs for the public health and protection of the greater population has clear legal precedents.³⁹

VARIOUS STRATEGIES THAT MAY BE USED TO IMPLEMENT MANDATORY HCP INFLUENZA VACCINATION PROGRAMS

Employee vaccination programs may differ in the various tools used to implement a policy of mandatory influenza vaccination of HCP as a condition of employment. As noted in the 2005 SHEA Position Paper,¹ programmatic principles should include that the program be comprehensive and provide ready access to vaccination, provision of vaccination free to HCP, targeted education that emphasizes the rationale for a mandatory policy, leadership commitment, and resources. In this section we describe some newer strategies used by healthcare facilities to improve influenza control programs that also may have a role in a mandatory vaccination program and that provide tools for those rare individuals who cannot receive vaccination or who refuse to participate in the influenza vaccination program.

Use of Vaccination Rates as a Measure of a Facility's Safety and Quality Program

One method to help increase influenza vaccination rates is through shared reporting of individual facility influenza vaccination rates as an indicator of an institution's commitment to the delivery of safe, quality care. Appropriate concerns regarding public reporting of other healthcare-associated infection outcomes, such as risk adjustment and comparability of patient populations between different facilities, are negligible when examining HCP vaccination rates. HCP vaccination rates and aspects of a facility's vaccination program have already been included in various assessments of the quality of patient care as a patient safety indicator.^{43,44} A strategy involving shared disclosure of vaccination rates has been successful in Iowa, in which a voluntary collaborative involving all 115 acute care hospitals in the state reported institution-specific vaccination rates and strategies used to improve those rates to all member facilities.⁴⁵ Although these data were not reported to the general public, this program led to median vaccination rates of 82% in the second year of the program. Coupling such reporting with vaccination mandates would serve to drive these rates even higher. However, before reporting such data as a quality metric, the HCP population included in a facility's measurement must be clearly defined to allow for accurate interfacility comparisons. In addition, such programs should report actual HCP vaccination rates, rather than overall vaccination program participation rates, which may be elevated because of high rates of vaccination refusal or exemption.

Requiring Unvaccinated HCP to Wear a Mask during the Influenza Season

Some organizations that have implemented a mandatory vaccination program also have required those HCP who refuse

or are unable to receive the vaccination to wear a surgical mask while performing clinical care duties during the influenza season.^{23,25} The rationale behind such a strategy is that the masks can serve as a method for source control of infected HCP who may have limited or no symptoms yet who still may shed virus; the masks also protect unvaccinated HCP from as-yet-unrecognized, unisolated influenza patients.⁴⁶ The use of masks, in conjunction with hand hygiene, has been associated with a reduction in rates of ILI in residents of college dormitories and households.^{47,48} The requirement for mask use may prompt HCP to review more closely the risk-benefit ratio for vaccination and to choose to receive the vaccination. Although largely anecdotal, such an effect has been reported by researchers in Germany, where HCP vaccination rates climbed from 33% to 51.7% in the 10 days following implementation of a requirement for unvaccinated HCP to wear a mask during all direct patient contact.⁴⁹ Such data have led some groups to recommend such requirements as part of a mandatory vaccination program.⁵⁰

There are, however, potential issues related to the masking requirement. Implementation of such a policy is logistically challenging (eg, developing methods to identify those HCP required to wear a mask during clinical care in order to correct noncompliance). Some institutions have used identification badge stickers or buttons for such a purpose. The use of such identifiers, however, may risk stigmatizing those HCP with legitimate contraindications to vaccination and has raised concerns regarding HCP's right to privacy. If used, such identifiers should be crafted in a manner that positively reinforces the rationale for mask use. For example, some systems have used nonpunitive identification badges for both vaccinated and unvaccinated HCP with safety messages that positively emphasized the HCP's role in preventing infection in their patients, whether through vaccination or through wearing a mask (Figure 1).

Although SHEA does not specifically endorse policies that require unvaccinated HCP to wear a mask during the influenza season, the Society believes there is potential utility in this strategy to prevent inadvertent transmission of influenza and perhaps also to achieve higher vaccination coverage.

Use of Signed Declination Statements for HCP Who Refuse Vaccination

In its 2005 Position Paper,¹ SHEA supported the use of signed declination statements for those persons refusing vaccination as a tool to reinforce the risks associated with unvaccinated HCP to both patients and the HCP themselves. Since publication of the 2005 SHEA Position Paper,¹ more data on the impact of these statements have become available. The use of such statements as a part of a comprehensive vaccination program has led to modest increases in coverage in some instances.⁵¹⁻⁵⁴ The impact of such statements, however, is variable,^{55,56} likely affected by the content of the declination (eg, wording that notes risks to patients by refusing vaccination) as well as its context (eg, a requirement for a face-to-face meeting to review the reasons for refusal, or an Internet-based tool).⁴² Accordingly, use of these statements should not be viewed as the primary method for increasing vaccination rates. In the context of mandatory HCP influenza vaccination programs with limited exemptions to vaccination, the use of these statements may be limited. If used, such statements should outline all expected infection control practices the HCP should perform to reduce influenza transmission and should note the impact of unvaccinated HCP.

REVISED SHEA POSITION ON INFLUENZA VACCINATION OF HCP

SHEA views influenza vaccination of HCP as a *core patient and HCP safety practice* with which noncompliance should



FIGURE 1. Example of badge identifiers for both vaccinated (A) and unvaccinated (B) healthcare personnel used as part of the mandatory influenza vaccination program of Hospital Corporation of America (courtesy of E. Septimus).

not be tolerated. We believe that it is the professional and ethical responsibility of HCP and the institutions within which they work to prevent the spread of infectious pathogens to their patients by following evidence-based infection prevention practices. Just as HCP would not be allowed to participate in a surgical procedure without first performing an appropriate surgical hand scrub or wearing appropriate sterile attire, failure to perform a basic patient safety intervention, such as influenza vaccination, is unacceptable. Therefore, for the safety of patients and HCP, SHEA endorses a policy in which influenza vaccination is an ongoing condition of HCP employment, unpaid service, or receipt of professional privileges.

Although it is a cornerstone in prevention, influenza vaccination is not and cannot be the only intervention used for the prevention of influenza transmission in healthcare settings. This policy must be implemented as part of a multifaceted, comprehensive infection control program (as outlined in the SHEA 2005 Position Paper¹) that emphasizes all aspects of an influenza control program: it must have full, visible leadership support with the expectation for vaccination fully and clearly communicated to all HCP, and it must be provided with adequate resources and support for the HCP vaccination program. As noted above, it also must address all the practices necessary to reduce the spread of influenza in healthcare settings, including patient isolation, use of personal protective equipment, hand hygiene, and visitor and HCP restriction when ill. Because the types of HCP included in vaccination programs may vary, with contract staff, private physicians, students, and volunteers often excluded, this recommendation applies to all HCP practicing in all healthcare settings (including contract workers, independent practitioners, volunteers, students, and product vendors), regardless of whether the HCP have direct patient contact or whether the HCP are directly employed by the facility.^{57,58}

Exemptions to influenza vaccination mandates should be allowed only for medical contraindications to vaccination, specifically allergy to eggs and prior allergic or severe adverse reactions to influenza vaccine. Such exemptions should be adequately documented and reviewed before allowing exemption from this requirement. Some facilities have allowed religious exemptions as part of HCP vaccination programs requiring that those requesting a religious exemption demonstrate a deeply held conviction, as determined by review by an institutional panel. However, most religions do not prohibit vaccination. Legal pressures to avoid discrimination implied by allowing religious exemptions for only one religion or by requiring an individual to belong to an organized religion in order to get a religious exemption have broadened the use of religious exemptions to others. Because vaccination of HCP is a patient safety and public health intervention, SHEA does not endorse the use of religious exemptions to influenza vaccination, because failure to be vaccinated results in an unacceptable risk to patients and other HCP. Legal support for such policies has been noted with school-entry

vaccination requirements, in which the absence of religious exemptions has been legally upheld against objections that such policies infringed on individuals' religious principles.³⁹

Personal belief or philosophical exemptions (eg, for those who do not believe in the need for influenza vaccination or for those who are opposed to the concept of *mandatory* vaccination) should not be allowed. The allowance of personal belief exemptions for school-entry vaccination requirements has been associated with an increased risk of the acquisition and transmission of vaccine-preventable diseases.⁵⁹ Although a few facilities and systems have been successful in achieving high vaccination rates in the setting of personal belief exemptions,^{25,60} allowance of personal belief exemptions runs counter to the concept that HCP influenza vaccination is a core patient safety intervention from which the HCP cannot merely opt out, particularly given the known safety and efficacy of influenza vaccination.

SHEA now joins multiple organizations and regulatory agencies that have recommended influenza vaccination be a condition of employment for HCP. In 2008, the Department of Defense expanded the policy requiring influenza vaccination for all Department of Defense HCP providing direct patient care in military treatment facilities to include all contract and other civilian HCP working in such a capacity.⁶¹ The Infectious Diseases Society of America revised their recommendations on HCP influenza vaccination in 2009 to endorse "universal immunization of health care workers against seasonal...influenza by health care institutions through mandatory vaccination programs," allowing only medical and religious exemptions.⁵⁰ The Association of Professionals in Infection Control and Epidemiology has also recommended that "influenza vaccine...be required annually for all healthcare personnel with direct patient care," but allows for personal belief exemptions by means of signed declinations.⁶² Recommending that only medical exemptions be allowed, the National Patient Safety Foundation also now endorses mandatory influenza vaccination of HCP "to protect the health of patients, health care workers, and the community."⁶³

CHALLENGES TO MANDATORY INFLUENZA VACCINATION PROGRAMS

A program that requires influenza vaccination as a condition of employment, privileges, or other hospital activity, such as volunteer work, may be met with several challenges that should be identified and addressed in advance in order to successfully implement this patient safety program. Visible and emphatic leadership expectation for vaccination is essential, as is accountability for vaccination, by means of annual performance evaluations or physician credentialing requirements. Managers and leaders must be provided with the vaccination compliance data at regular timely intervals. In addition to leadership support, vaccination programs must have appropriate allocation of resources (financial resources and personnel). Plans and policies to capture HCP influenza

vaccination receipt outside of the formal employee vaccination program must be developed to document and to allow for accurate assessment of vaccination coverage. In addition, policies requiring vaccination must consider the impact of factors that may limit the availability of vaccine, and facilities should modify such requirements during instances of vaccine shortages.

Because influenza vaccine manufacturing has expanded significantly, shortages are expected to be less common than in the past. Nonetheless, should vaccine shortages occur, it may be appropriate for influenza vaccination requirements to be prioritized to those personnel at highest risk of exposure to infected patients or to those who provide the highest degree of contact (eg, prolonged duration and frequency of contact) to patients at high risk for influenza complications. Vaccination program leadership should be cognizant that messages about vaccine prioritization at the time of shortages may cause some confusion. HCP may infer that vaccine prioritization implies that vaccination is really important only for certain HCP. Therefore, it is essential to emphasize that, although the best strategy for preventing healthcare-associated influenza transmission involves protection of both HCP and patients through universal vaccination, in times of limited resources, a less-than-optimal approach is needed. Program leaders also should emphasize that HCP not targeted by the vaccination prioritization need to use fully the other protective modalities (eg, early recognition of cases, use of personal protective equipment, and strict adherence to hand hygiene) to prevent viral transmission.

Opponents of mandatory HCP vaccination policies cite several concerns regarding a mandatory approach. Specifically, some believe that such policies could place frontline HCP, who are essential for implementation of other key infection prevention initiatives, at odds with facility leadership. SHEA agrees that frontline HCP are key to successful infection prevention, quality improvement, and safety programs. However, clear communication to all existing and potential (ie, applicant) HCP regarding the rationale for an influenza vaccination requirement (ie, that the goal is to protect both patients and HCP) and a trusting partnership of leadership with frontline workers in implementing this safety initiative will help address these concerns. Among the multiple institutions that have already instituted such conditions of employment, extraordinarily high levels of acceptance have been demonstrated. In addition, having leaders at the highest level, rather than midlevel managers, set policy regarding employee vaccination may further lessen potential friction with frontline personnel. The success of mandatory vaccination programs at institutions such as VMMC, BJC Healthcare, and Hospital Corporation of America can be attributed completely to strong leadership messaging and partnership with all HCP, and a consistent focus on the goal of patient safety and welfare consistent with the ethics of the healthcare professions. Other opponents of mandatory vaccination programs have voiced concerns that such mandates will divert

resources from and reduce adherence to basic influenza infection control practices, such as hand hygiene; however, non-adherence to other practices in circumstances with similar safety requirements has not been documented and does not appear to be a valid concern.

A major challenge to mandatory influenza vaccination programs involves potential resistance by organized employee organizations. For example, the VMMC program was faced with a legal challenge from the Washington State Nurses Association, which led to the adoption of a policy requiring masks for all unvaccinated HCP. It should be noted that these groups and the HCP they represent for the most part do not oppose the concept of influenza vaccination but rather the mandatory nature of such policies. However, vaccination is a core preventive patient safety method and should be required, as it is required to wear appropriate attire in the operating room, it is prohibited to wear artificial fingernails, and it is required to provide care to patients regardless of underlying disease, even when they have disease that might place the HCP at some risk (eg, pandemic influenza, viral hemorrhagic fever, bloodborne pathogen infection, and other illnesses). One hopes that, in the interests of protecting both patients and their members, these organizations will not oppose mandatory programs that are developed in collaboration with employees, with transparency and due process for needed exemptions. In addition, labor organizations, if involved in a collaborative interaction with facility leaders, may also help emphasize the importance of influenza prevention strategies to protect both patients and HCP. Finally, facilities also should examine collective bargaining agreements and should anticipate including influenza vaccination requirements into renewed agreements. Such leadership represents a serious commitment to patient and HCP safety and should be valued as such.

CONCLUSIONS

Influenza vaccination of HCP is an important and key component of infection prevention programs designed to reduce healthcare-associated influenza. As with any core patient safety practice, low rates of compliance that place patients and HCP at risk are unacceptable. Because HCP influenza vaccination rates in the setting of voluntary programs have remained low over the nearly 3 decades that HCP influenza vaccination has been recommended, SHEA endorses policies that require influenza vaccination as a condition of employment as part of a comprehensive influenza infection control program.

APPROVAL AND ENDORSEMENT

This position paper has been approved by the Board of the Society of Healthcare Epidemiology of America and endorsed by the Infectious Diseases Society of America.

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Address reprint requests to Thomas R. Talbot, MD, MPH, A-2200 Medical Center North, 1161 21st Ave South, Vanderbilt University Medical Center, Nashville, TN 37232 (tom.talbot@vanderbilt.edu).

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Original Investigation | Infectious Diseases

Risk Factors Associated With SARS-CoV-2 Seropositivity Among US Health Care Personnel

Jesse T. Jacob, MD; Julia M. Baker, PhD; Scott K. Fridkin, MD; Benjamin A. Lopman, PhD; James P. Steinberg, MD; Robert H. Christenson, PhD; Brent King, MD; Surbhi Leekha, MBBS; Lyndsay M. O'Hara, PhD; Peter Rock, MD, MBA; Gregory M. Schrank, MD; Mary K. Hayden, MD; Bala Hota, MD, MPH; Michael Y. Lin, MD, MPH; Brian D. Stein, MD, MS; Patrizio Caturegli, MD; Aaron M. Milstone, MD, MHS; Clare Rock, MD, MS; Annie Voskertchian, MPH; Sujana C. Reddy, MD; Anthony D. Harris, MD

Abstract

IMPORTANCE Risks for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection among health care personnel (HCP) are unclear.

OBJECTIVE To evaluate the risk factors associated with SARS-CoV-2 seropositivity among HCP with the a priori hypothesis that community exposure but not health care exposure was associated with seropositivity.

DESIGN, SETTING, AND PARTICIPANTS This cross-sectional study was conducted among volunteer HCP at 4 large health care systems in 3 US states. Sites shared deidentified data sets, including previously collected serology results, questionnaire results on community and workplace exposures at the time of serology, and 3-digit residential zip code prefix of HCP. Site-specific responses were mapped to a common metadata set. Residential weekly coronavirus disease 2019 (COVID-19) cumulative incidence was calculated from state-based COVID-19 case and census data.

EXPOSURES Model variables included demographic (age, race, sex, ethnicity), community (known COVID-19 contact, COVID-19 cumulative incidence by 3-digit zip code prefix), and health care (workplace, job role, COVID-19 patient contact) factors.

MAIN OUTCOME AND MEASURES The main outcome was SARS-CoV-2 seropositivity. Risk factors for seropositivity were estimated using a mixed-effects logistic regression model with a random intercept to account for clustering by site.

RESULTS Among 24 749 HCP, most were younger than 50 years (17 233 [69.6%]), were women (19 361 [78.2%]), were White individuals (15 157 [61.2%]), and reported workplace contact with patients with COVID-19 (12 413 [50.2%]). Many HCP worked in the inpatient setting (8893 [35.9%]) and were nurses (7830 [31.6%]). Cumulative incidence of COVID-19 per 10 000 in the community up to 1 week prior to serology testing ranged from 8.2 to 275.6; 20 072 HCP (81.1%) reported no COVID-19 contact in the community. Seropositivity was 4.4% (95% CI, 4.1%-4.6%; 1080 HCP) overall. In multivariable analysis, community COVID-19 contact and community COVID-19 cumulative incidence were associated with seropositivity (community contact: adjusted odds ratio [aOR], 3.5; 95% CI, 2.9-4.1; community cumulative incidence: aOR, 1.8; 95% CI, 1.3-2.6). No assessed workplace factors were associated with seropositivity, including nurse job role (aOR, 1.1; 95% CI, 0.9-1.3), working in the emergency department (aOR, 1.0; 95% CI, 0.8-1.3), or workplace contact with patients with COVID-19 (aOR, 1.1; 95% CI, 0.9-1.3).

CONCLUSIONS AND RELEVANCE In this cross-sectional study of US HCP in 3 states, community exposures were associated with seropositivity to SARS-CoV-2, but workplace factors, including

(continued)

Key Points

Question What risk factors are associated with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) seropositivity among health care personnel (HCP) inside and outside the workplace?

Findings In this cross-sectional study of 24 749 HCP in 3 US states, contact with an individual with known coronavirus disease 2019 (COVID-19) exposure outside the workplace was the strongest risk factor associated with SARS-CoV-2 seropositivity, along with living in a zip code with higher COVID-19 incidence. None of the assessed workplace factors were associated with seropositivity.

Meaning In this study, most risk factors associated with SARS-CoV-2 infection among HCP were outside the workplace, suggesting that current infection prevention strategies in health care are effective in preventing patient-to-HCP transmission in the workplace.

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Author affiliations and article information are listed at the end of this article.

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Abstract (continued)

workplace role, environment, or contact with patients with known COVID-19, were not. These findings provide reassurance that current infection prevention practices in diverse health care settings are effective in preventing transmission of SARS-CoV-2 from patients to HCP.

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Introduction

Since coronavirus disease 2019 (COVID-19) was recognized in the United States in January 2020, the risk of infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) attributed to exposures in the health care workplace has been studied with conflicting results.¹⁻⁶ It remains unclear whether certain job functions or specific workplace activities, including care for individuals with known and unknown SARS-CoV-2 positivity, increase the risk of SARS-CoV-2 infection. Furthermore, it is still unknown whether the association of individual and job-related characteristics and risk of SARS-CoV-2 infection are consistent across health care systems and over time.

To address these knowledge gaps, 4 sites in the US Centers for Disease Control and Prevention (CDC) Prevention Epicenters Program, based in academic institutions that collaborate with each other and the CDC to perform innovative infection prevention research, used previously collected serosurvey data to determine the prevalence of antibodies to SARS-CoV-2 in a large multistate study of US health care personnel (HCP). We sought to identify risk factors associated with seropositivity, including HCP demographic characteristics, work location, work exposure to patients with COVID-19, and community exposure to COVID-19 with the a priori hypothesis that community exposure but not health care exposure was associated with seropositivity. Our study builds on a prior single Prevention Epicenter cross-sectional study⁷ that explored specific workplace activities unique to that system.

Methods

Participating Academic Centers

We assessed SARS-CoV-2 seroprevalence in large health care systems affiliated with 4 Prevention Epicenters in Atlanta, Georgia (Emory Healthcare), Baltimore, Maryland (Johns Hopkins Medicine and University of Maryland Medical System), and Chicago, Illinois (Rush University System). The systems were primarily based in metropolitan areas and predominantly acute care hospitals, but they included more than 100 affiliated regional ambulatory locations, administrative locations, rehabilitation facilities, and skilled nursing facilities.

This study was reviewed by each site's institutional review board and either approved or determined to be non-human participant research. At each site where this activity was deemed human participant research, a waiver for informed consent was obtained or individual informed consent was obtained. This activity was reviewed by the CDC and was conducted consistent with applicable federal law and CDC policy (eg, 45 CFR part 46; 21 CFR part 56; 42 USC §241(d); 5 USC §552a; 44 USC §3501). This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.

Serologic Testing, Data Collection, and Data Compilation

All badged HCP at each site were eligible to participate. Each site independently designed and conducted a voluntary HCP serological survey. The activities were started and implemented as part of internal quality and occupational safety assessments or research activities in each health care system. At the time of specimen collection, HCP completed a site-specific survey, including occupational activities and possible exposures to individuals with SARS-CoV-2 infection both inside and outside the workplace. Race and ethnicity were self-reported by HCP using categories defined by

each site and were included in this study because of prior reports of racial disparities in SARS-CoV-2 seropositivity.^{4,8,9} Subsequently, we combined specimen and survey data collected between the weeks of April 19 and August 30, 2020.

The serological test used at each of the sites met the US Food and Drug Administration emergency use criteria and all measured immunoglobulin G.¹⁰ The Abbott Architect assay (Abbott Laboratories), targeting the nucleocapsid protein, was used at Rush. Emory used a laboratory-developed assay,¹¹ and Johns Hopkins used the QuantiVac ELISA (EUROIMMUN), both of which target the receptor binding domain of the SARS-CoV-2 spike protein.¹² For the University of Maryland, only samples testing positive by both the VITROS assay (Ortho Clinical Diagnostics) and a laboratory-developed ELISA, both targeting the spike protein, were interpreted as positive for this study.

Sites shared a limited data set (without protected health information) for the combined analysis, including date and results of serology, 3-digit prefix of participants' residential zip code, and survey responses. Because survey content varied between sites, questions from each survey were mapped to a common metadata set across the 4 sites. In some instances, text or ordinal values were mapped to categorical values to allow inclusion of data from all facilities, while in other instances substantial differences in the surveys prohibited definitive mapping. Mapping of key health care exposure variables are detailed in eTable 1 in the [Supplement](#). Variables that could not be mapped definitively across facilities due to differences in question wording or response categories were excluded. The date of specimen collection was converted to the week number since January 1, 2020. Age was categorized by decade (ie, <30, 30-39, 40-49, 50-59, and ≥60 years) in the limited data set. Workplace location was categorized as emergency department, inpatient (regardless of direct care of patients with COVID-19), other locations (ambulatory, perioperative, surgical, rehabilitation or postacute care, no patient contact, worked from home), or unknown location. Because working in COVID-19-focused areas was captured differently across all sites, COVID-19 care was categorized as never providing COVID-19 care or providing any COVID-19 care. HCP were categorized into mutually exclusive job roles.

In addition to self-reported community contact with individuals with COVID-19, we assigned a zip code-based value of community exposure to COVID-19 to each HCP. Weekly data on the number of COVID-19 cases by 3-digit zip code prefix were obtained from the state departments of health in Georgia, Illinois, and Maryland. These data were combined with census population data to calculate weekly COVID-19 cumulative incidence by 3-digit zip code. Each participant in our metadata set was then assigned the value of COVID-19 cumulative incidence in their zip code of residence until 1 week prior to their test date.

Statistical Analysis

We calculated the prevalence of SARS-CoV-2 seropositivity overall (combined across all sites) and for each site. The overall seropositivity was first modeled using unadjusted bivariate logistic regression assessing the association of each individual potential risk factor with seropositivity. We developed a mixed-effects logistic regression model, with a random intercept to account for clustering by the 4 sites, to estimate adjusted odds ratios (aORs) and 95% CIs between potential risk factors and SARS-CoV-2 seropositivity across all 4 sites. Model variables included demographic characteristics (sex, age group, race, ethnicity), community contact, COVID-19 cumulative incidence (base-10 logarithm of the COVID-19 cumulative incidence), and occupational factors (job role, workplace location, any contact with a patient with COVID-19).

Three sensitivity analyses were performed. We chose to include a random intercept in our main model to produce effect estimates representing the association between workplace factors and seropositivity across all 4 health care systems combined. A sensitivity analysis using logistic regression without a random intercept was performed and compared with the main model to determine whether including the random intercept improved model fit. A second sensitivity analysis included a time variable (month of test) in the model to account for monthly variations in

unmeasured confounders. Lastly, we applied our main model to a subset of data excluding Emory to assess whether key risk factors identified in a detailed Emory-only analysis⁷ remained risk factors in this larger analysis. Analyses were conducted in R version 4.0.2 (R Project for Statistical Computing) using the lme4 package, and the code is publicly available.¹³ No prespecified level of statistical significance was set.

Results

Among 24 952 participants from the 4 health care systems, 203 (0.8%) with indeterminate serology test results were excluded from further analysis. Of the remaining 24 749 participants, 10 275 (41.5%) were from Emory, 1626 (6.6%) from Johns Hopkins, 2470 (10.0%) from Rush, and 10 378 (41.9%) from University of Maryland. Most HCP were younger than 50 years (17 233 [69.6%]), women (19 361 [78.2%]), White individuals (15 157 [61.2%]), and non-Hispanic individuals (22 403 [90.5%]), with a large proportion of Black individuals (5117 [20.7%]). Testing volume peaked at different times at each site between April and August 2020 (**Figure 1**). Seropositivity for SARS-CoV-2 was 4.4% (95% CI, 4.1%-4.6%; 1080 HCP) overall and did not differ substantially by site (**Table 1**). Most HCP reported working predominantly in acute care hospitals (21 566 [87.1%]), with much smaller proportions working predominantly in ambulatory settings (1303 [5.3%]) or long-term care or inpatient rehabilitation facilities (630 [2.5%]); the remainder worked in administrative or other locations.

Setting and Participants

HCP resided in diverse locations both inside and outside of the metropolitan areas the health care systems served, encompassing most of Georgia, Maryland, and northeastern Illinois. HCP worked in more than 100 different physical locations clustered near academic centers (**Figure 2**). Major infection control practices were generally consistent across sites, although there was some variation between sites and changes during the study period (eTable 3 in the [Supplement](#)).

Community Factors and COVID-19 Incidence

Cumulative incidence of COVID-19 in the community, linked to HCP residence by 3-digit zip code 1 week prior to serology testing, ranged from 8.2 cases per 10 000 to 275.6 cases per 10 000.

Figure 1. Number of Total Health Care Personnel Participating by Week and Health Care System

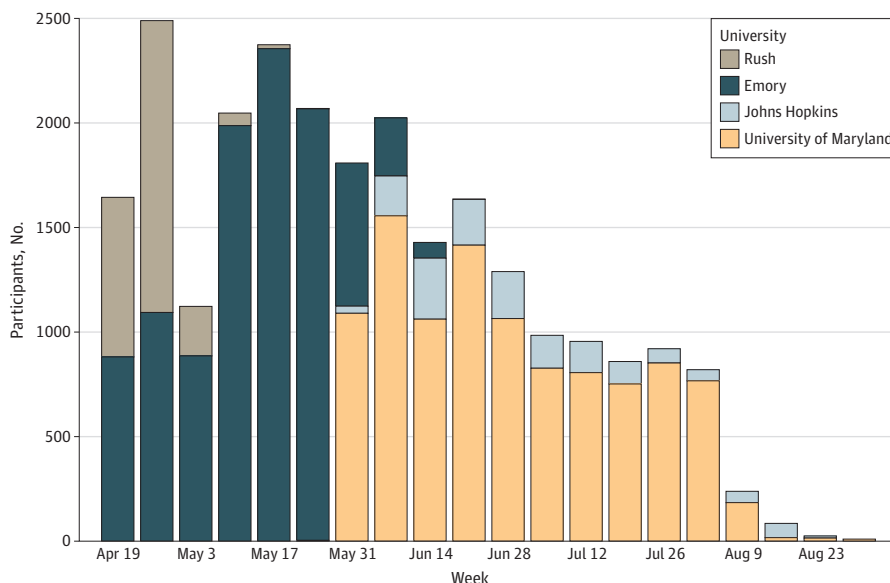


Table 1. Baseline Demographic and Key Characteristics of the 24 749 HCP in the Study

Characteristic	HCP, No. (%)		Emory		Johns Hopkins		University of Maryland		Rush	
	All systems									
	Total ^a	With SARS-CoV-2 ^b	Total ^a	With SARS-CoV-2 ^b	Total ^a	With SARS-CoV-2 ^b	Total ^a	With SARS-CoV-2 ^b	Total ^a	With SARS-CoV-2 ^b
Demographic and community factors										
Total participants	24 749 (100.0)	1080 (4.4)	10 275 (100.0)	582 (5.7)	1626 (100.0)	80 (4.9)	10 378 (100.0)	319 (3.1)	2470 (100.0)	99 (4.0)
Sex										
Male	5378 (21.7)	240 (4.5)	2443 (23.8)	140 (5.7)	296 (18.2)	25 (8.4)	2104 (20.3)	56 (2.7)	535 (21.7)	19 (3.6)
Female	19 361 (78.2)	840 (4.3)	7832 (76.2)	442 (5.6)	1325 (81.5)	55 (4.2)	8274 (79.7)	263 (3.2)	1930 (78.1)	80 (4.1)
Other/unknown	10 (<0.1)	0	0	0	5 (0.3)	0	0	0	5 (0.2)	0
Age group, y										
≥60	2938 (11.9)	107 (3.6)	1238 (12.0)	59 (4.8)	146 (9.0)	11 (7.5)	1372 (13.2)	31 (2.3)	182 (7.4)	6 (3.3)
50-59	4578 (18.5)	178 (3.9)	1937 (18.9)	99 (5.1)	287 (17.7)	13 (4.5)	2045 (19.7)	58 (2.8)	309 (12.5)	8 (2.6)
40-49	5234 (21.1)	228 (4.4)	2284 (22.2)	131 (5.7)	336 (20.7)	12 (3.6)	2167 (20.9)	67 (3.1)	447 (18.1)	18 (4.0)
30-39	7454 (30.1)	328 (4.4)	3148 (30.6)	179 (5.7)	555 (34.1)	26 (4.7)	2859 (27.5)	92 (3.2)	892 (36.1)	31 (3.5)
<30	4545 (18.4)	239 (5.3)	1668 (16.2)	114 (6.8)	302 (18.6)	18 (6.0)	1935 (18.6)	71 (3.7)	640 (25.9)	36 (5.6)
Ethnicity										
Not Hispanic/Latino	22 403 (90.5)	975 (4.4)	9838 (95.7)	560 (5.7)	1551 (95.4)	77 (5.0)	8901 (85.8)	260 (2.9)	2113 (85.5)	78 (3.7)
Hispanic/Latino	1126 (4.5)	59 (5.2)	437 (4.3)	22 (5.0)	75 (4.6)	3 (4.0)	257 (2.5)	13 (5.1)	357 (14.5)	21 (5.9)
Unknown	1220 (4.9)	46 (3.8)	0	0	0	0	1220 (11.8)	46 (3.8)	0	0
Race										
White	15 157 (61.2)	499 (3.3)	5659 (55.1)	239 (4.2)	1274 (78.4)	59 (4.6)	6376 (61.4)	138 (2.2)	1848 (74.8)	63 (3.4)
American Indian or Alaska Native	105 (0.4)	5 (4.8)	33 (0.3)	2 (6.1)	1 (0.1)	0	58 (0.6)	1 (1.7)	13 (0.5)	2 (15.4)
Asian	2369 (9.6)	107 (4.5)	1253 (12.2)	65 (5.2)	179 (11.0)	9 (5.0)	679 (6.5)	19 (2.8)	258 (10.4)	14 (5.4)
Black or African American	5117 (20.7)	376 (7.3)	2986 (29.1)	246 (8.2)	108 (6.6)	8 (7.4)	1866 (18.0)	112 (6.0)	157 (6.4)	10 (6.4)
Multiracial	253 (1.0)	14 (5.5)	137 (1.3)	10 (7.3)	38 (2.3)	2 (5.3)	6 (0.1)	0	72 (2.9)	2 (2.8)
Native Hawaiian or other Pacific Islander	34 (0.1)	1 (2.9)	16 (0.2)	0	2 (0.1)	0	9 (0.1)	1 (11.1)	7 (0.3)	0
Other	702 (2.8)	25 (3.6)	0	0	24 (1.5)	2 (8.3)	563 (5.4)	15 (2.7)	115 (4.7)	8 (7.0)
Unknown	1012 (4.1)	53 (5.2)	191 (1.9)	20 (10.5)	0	0	821 (7.9)	33 (4.0)	0	0
Contact with person in community with COVID-19										
No	20 072 (81.1)	699 (3.5)	6607 (64.3)	338 (5.1)	1567 (96.4)	65 (4.1)	9735 (93.8)	228 (2.3)	2163 (87.6)	68 (3.1)
Yes	1730 (7.0)	218 (12.6)	804 (7.8)	81 (10.1)	59 (3.6)	15 (25.4)	561 (5.4)	91 (16.2)	306 (12.4)	31 (10.1)
Unknown or not reported	2947 (11.9)	163 (5.5)	2864 (27.9)	163 (5.7)	0	0	82 (0.8)	0	1	0
Cumulative community incidence of COVID-19 per 10 000, mean (range)	72.4 (8.2-275.6)		47.4 (8.2-150.4)		104.0 (45.2-273.6)		96.6 (18.8-275.6)		52.5 (10.7-147.5)	
Workplace factors										
Job role										
Nonclinical	5289 (21.4)	205 (3.9)	1857 (18.1)	102 (5.5)	260 (16.0)	9 (3.5)	2496 (24.1)	67 (2.7)	676 (27.4)	27 (4.0)
Nurse practitioner or physician's assistant	1535 (6.2)	53 (3.5)	795 (7.7)	39 (4.9)	119 (7.3)	4 (3.4)	521 (5.0)	7 (1.3)	100 (4.0)	3 (3.0)
Environmental services	122 (0.5)	9 (7.4)	37 (0.4)	3 (8.1)	1 (0.1)	0	80 (0.8)	6 (7.5)	4 (0.2)	0
Nurse	7830 (31.6)	374 (4.8)	3047 (29.7)	183 (6.0)	590 (36.3)	38 (6.4)	3425 (33.0)	123 (3.6)	768 (31.1)	30 (3.9)
Other direct care personnel ^c	1914 (7.7)	105 (5.5)	1488 (14.5)	90 (6.0)	4 (0.2)	0	394 (3.8)	14 (3.6)	28 (1.1)	1 (3.6)
Other health care professional ^d	367 (1.5)	10 (2.7)	0	0	113 (6.9)	5 (4.4)	86 (0.8)	0	168 (6.8)	5 (3.0)

(continued)

Table 1. Baseline Demographic and Key Characteristics of the 24 749 HCP in the Study (continued)

Characteristic	HCP, No. (%)									
	All systems		Emory		Johns Hopkins		University of Maryland		Rush	
	Total ^a	With SARS-CoV-2 ^b	Total ^a	With SARS-CoV-2 ^b	Total ^a	With SARS-CoV-2 ^b	Total ^a	With SARS-CoV-2 ^b	Total ^a	With SARS-CoV-2 ^b
Patient care technician, nursing assistant, nurse technician	1348 (5.4)	79 (5.9)	353 (3.4)	29 (8.2)	0	0	888 (8.6)	37 (4.2)	107 (4.3)	13 (12.1)
Pharmacy	325 (1.3)	10 (3.1)	0	0	35 (2.2)	4 (11.4)	215 (2.1)	6 (2.8)	75 (3.0)	0
Physician	4499 (18.2)	166 (3.7)	2116 (20.6)	97 (4.6)	388 (23.9)	18 (4.6)	1572 (15.1)	36 (2.3)	423 (17.1)	15 (3.5)
Physical, occupational, or speech therapist	483 (2.0)	17 (3.5)	0	0	76 (4.7)	1 (1.3)	339 (3.3)	13 (3.8)	68 (2.8)	3 (4.4)
Radiology technician	476 (1.9)	23 (4.8)	305 (3.0)	21 (6.9)	20 (1.2)	0	124 (1.2)	2 (1.6)	27 (1.1)	0
Respiratory therapist	399 (1.6)	18 (4.5)	115 (1.1)	7 (6.1)	20 (1.2)	1 (5.0)	238 (2.3)	8 (3.4)	26 (1.1)	2 (7.7)
Unknown	162 (0.7)	11 (6.8)	162 (1.6)	11 (6.8)	0	0	0	0	0	0
Workplace environment										
Inpatient for patients with and without COVID-19	8893 (35.9)	425 (4.8)	3576 (34.8)	218 (6.1)	713 (43.8)	37 (5.2)	3495 (33.7)	126 (3.6)	1109 (44.9)	44 (4.0)
Emergency department	2409 (9.7)	127 (5.3)	1103 (10.7)	75 (6.8)	152 (9.3)	7 (4.6)	955 (9.2)	35 (3.7)	199 (8.1)	10 (5.0)
Other	11 257 (45.5)	413 (3.7)	3821 (37.2)	192 (5.0)	761 (46.8)	36 (4.7)	5791 (55.8)	153 (2.6)	884 (35.8)	32 (3.6)
Unknown	2108 (8.5)	115 (5.5)	1775 (17.3)	97 (5.5)	0	0	144 (1.0)	5 (9.1)	278 (11.3)	13 (4.7)
Contact with patients with COVID-19										
No contact	11 435 (46.2)	448 (3.9)	5182 (50.4)	261 (5.0)	612 (37.6)	28 (4.6)	4287 (41.3)	116 (2.7)	1354 (54.8)	43 (3.2)
Any contact	12 413 (50.2)	584 (4.7)	4419 (43.0)	283 (6.4)	1014 (62.4)	52 (5.1)	6009 (57.9)	203 (3.4)	971 (39.3)	46 (4.7)
Unknown	901 (3.6)	48 (5.3)	674 (6.6)	38 (5.6)	0	0	82 (0.8)	0	145 (5.9)	10 (6.9)

Abbreviations: COVID-19, coronavirus disease 2019; HCP, health care personnel; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

^a Percentages represent percentage of column.

^b Percentages represent percentage of row.

^c Other direct care personnel includes dialysis technician, phlebotomist.

^d Other health care professional includes laboratory technician, student, medical technologist, and other categories unable to refine.

Community cumulative incidence during the periods of the serosurveys was generally higher for HCP at Johns Hopkins and the University of Maryland (eFigure in the [Supplement](#)), which conducted surveys later in the pandemic than Emory and Rush. Most HCP (20 072 [81.1%]) reported no known contact with a person confirmed or suspected of having COVID-19 in their community (Table 1).

Workplace Factors

At all sites, nurse was the most common job role, with 7830 (31.6%) of the total study population (range, 3047 [29.7%] to 590 [36.3%]), followed by nonclinical staff (5289 [21.4%], eg, administrative staff, researchers, security) and physicians (4499 [18.2%]). More than one-third of HCP (8893 [35.9%]) reported working in inpatient settings (regardless of whether focused on COVID-19 care or not), 2409 (9.7%) reported working in the emergency department, and nearly half (11 257 [45.5%]) worked in other areas. Half of HCP (12 413 [50.2%]) reported caring for patients with COVID-19 or working in COVID-19–designated units.

Regression Model Results

Of the 24 749 participants with determinate serology results, 1201 (4.9%) were excluded because of missing or out-of-state zip codes, leaving 23 548 (95.1%) for the multivariable analysis. Demographic and community factors were associated with higher odds of seropositivity among HCP (**Table 2**). HCP younger than 30 years had increased odds of being seropositive for SARS-CoV-2 compared with HCP 60 years of age and older (aOR, 1.3; 95% CI, 1.0–1.7); the odds of seropositivity generally

decreased with increasing age. Black or African American HCP had more than twice the odds of being seropositive compared with White HCP (aOR, 2.1; 95% CI, 1.8-2.4). Sex was not associated with seropositivity.

HCP who reported having contact with a person known to have or suspected of having COVID-19 in the community had substantially increased odds of seropositivity compared with HCP with no known COVID-19 contacts outside of work (aOR, 3.5; 95% CI, 2.9-4.1). Zip code-based COVID-19 cumulative incidence (log 10) was also associated with increased odds of seropositivity (aOR, 1.8; 95% CI, 1.3-2.6).

No workplace factors were found to be associated with SARS-CoV-2 seropositivity among HCP in the multivariable regression model. Generally, any job role association with SARS-CoV-2 infection in the unadjusted analysis was attenuated in the multivariable model. Increased odds of seropositivity were estimated for HCP in environmental services (aOR, 1.5; 95% CI, 0.8-3.1) and physical, occupational, or speech therapy (aOR, 1.3; 95% CI, 0.7-2.1) compared with HCP in nonclinical roles in the multivariable model; however, the precision of these estimates was limited by the small number of HCP categorized in these roles. Notably, nurses did not have substantially

Figure 2. Geographic Distribution of Health Care Personnel in Each 3-Digit Zip Code and Work Locations

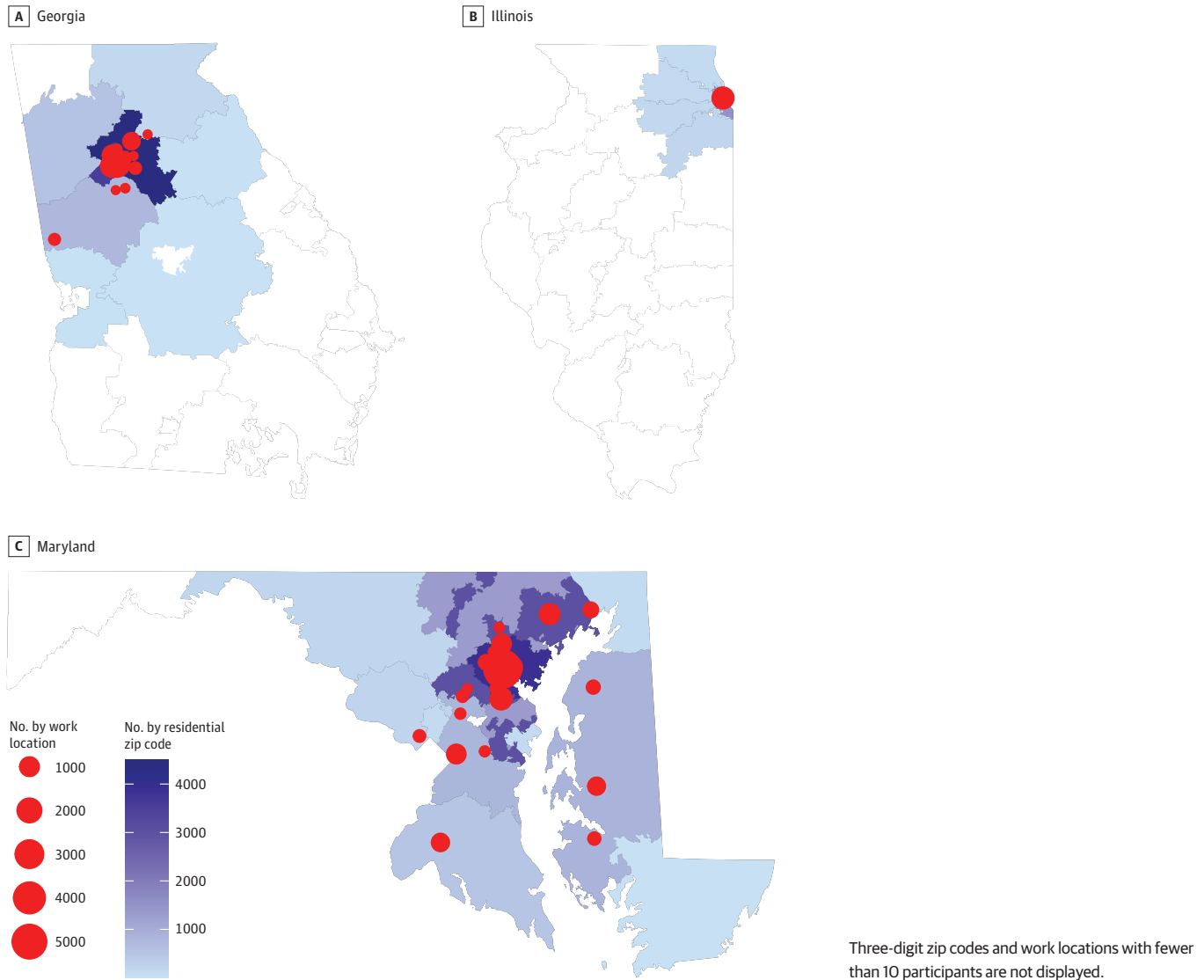


Table 2. Results of Logistic Regression Analyses, Unadjusted and Adjusted, for 4 Health Care Systems With Severe Acute Respiratory Syndrome Coronavirus 2 Serology as the Outcome Variable

Factor	OR (95% CI)	
	Unadjusted (N = 24 749) ^a	Adjusted (n = 23 548) ^b
Demographic and community factors		
Sex		
Male	1 [Reference]	1 [Reference]
Female	1.0 (0.8-1.1)	0.8 (0.7-1.0)
Other or unknown	0.0 (NA-12.8)	0.0 (0.0-NA)
Age group, y		
≥60	1 [Reference]	1 [Reference]
50-59	1.1 (0.8-1.4)	0.9 (0.7-1.2)
40-49	1.2 (1.0-1.5)	1.0 (0.8-1.3)
30-39	1.2 (1.0-1.5)	1.1 (0.9-1.4)
<30	1.5 (1.2-1.9)	1.3 (1.0-1.7)
Ethnicity		
Not Hispanic/Latino	1 [Reference]	1 [Reference]
Hispanic/Latino	1.2 (0.9-1.6)	1.1 (0.8-1.5)
Unknown	0.9 (0.6-1.2)	0.9 (0.6-1.4)
Race		
White	1 [Reference]	1 [Reference]
American Indian or Alaska Native	1.5 (0.5-3.3)	1.4 (0.6-3.5)
Asian	1.4 (1.1-1.7)	1.2 (1.0-1.5)
Black or African American	2.3 (2.0-2.7)	2.1 (1.8-2.4)
Multiracial	1.7 (1.0-2.9)	1.3 (0.8-2.3)
Native Hawaiian or other Pacific Islander	0.9 (0.0-4.1)	0.8 (0.1-6.2)
Other	1.1 (0.7-1.6)	1.3 (0.8-2.0)
Unknown	1.6 (1.2-2.1)	1.8 (1.2-2.7)
Contact with person with COVID-19 in community		
No	1 [Reference]	1 [Reference]
Yes	4.0 (3.4-4.7)	3.5 (2.9-4.1)
Unknown or not reported	1.6 (1.4-1.9)	1.3 (1.0-1.5)
Cumulative community incidence of COVID-19 (log 10)	0.9 (0.7-1.2)	1.8 (1.3-2.6)
Workplace factors		
Job role		
Nonclinical	1 [Reference]	1 [Reference]
Nurse practitioner or physician's assistant	0.9 (0.6-1.2)	0.9 (0.6-1.2)
Environmental services	2.0 (0.9-3.7)	1.5 (0.8-3.1)
Nurse	1.2 (1.0-1.5)	1.1 (0.9-1.3)
Other direct care personnel ^c	1.4 (1.1-1.8)	1.1 (0.9-1.4)
Other health care professional ^d	0.7 (0.3-1.3)	0.7 (0.4-1.3)
Patient care technician, nursing assistant, nurse technician	1.5 (1.2-2.0)	1.2 (0.9-1.6)
Pharmacy	0.8 (0.4-1.4)	0.8 (0.4-1.6)
Physician	1.0 (0.8-1.2)	0.9 (0.7-1.1)
Physical, occupational, or speech therapist	0.9 (0.5-1.5)	1.3 (0.7-2.1)
Radiology technician	1.3 (0.8-1.9)	1.0 (0.6-1.6)
Respiratory therapist	1.2 (0.7-1.9)	0.9 (0.5-1.6)
Unknown	1.8 (0.9-3.2)	0.9 (0.4-1.8)
Workplace environment		
Inpatient for patients with and without COVID-19	1 [Reference]	1 [Reference]
Emergency department	1.1 (0.9-1.4)	1.0 (0.8-1.3)
Other	0.8 (0.7-0.9)	0.9 (0.7-1.0)
Unknown	1.1 (0.9-1.4)	0.9 (0.7-1.2)

(continued)

Table 2. Results of Logistic Regression Analyses, Unadjusted and Adjusted, for 4 Health Care Systems With Severe Acute Respiratory Syndrome Coronavirus 2 Serology as the Outcome Variable (continued)

Factor	OR (95% CI)	
	Unadjusted (N = 24 749) ^a	Adjusted (n = 23 548) ^b
Contact with patients with COVID-19		
No contact	1 [Reference]	1 [Reference]
Any contact	1.2 (1.1-1.4)	1.1 (0.9-1.3)
Unknown	1.4 (1.0-1.9)	1.3 (0.9-1.9)

Abbreviations: COVID-19, coronavirus disease 2019; NA, not applicable; OR, odds ratio.

^a Crude OR between the specified factor and severe acute respiratory syndrome coronavirus 2 seropositivity using logistic regression.

^b OR for the association between the specified factor and severe acute respiratory syndrome coronavirus 2 seropositivity using mixed-effects logistic regression controlling for all other factors in the table and adjusting for correlation within each health care system (via inclusion of a random intercept). Random intercept had a variance of 0.07 (SD, 0.27).

^c Other direct care personnel includes dialysis technician or phlebotomist.

^d Other health care professional includes laboratory technician, student, medical technologist, other categories unable to refine.

increased odds of being seropositive (aOR, 1.1; 95% CI, 0.9-1.3). Neither working in the emergency department (aOR, 1.0; 95% CI, 0.8-1.3) nor providing care for patients with COVID-19 (aOR, 1.1; 95% CI, 0.9-1.3) increased the odds of seropositivity. The results from the sensitivity analyses excluding Emory data (eTable 2 in the [Supplement](#)), accounting for month of test (eTable 3 in the [Supplement](#)), and using a fixed-effects model (eTable 4 in the [Supplement](#)) were similar to those of the main model. Including a random slope in the model improved model fit when compared with the fixed-effects model (eTable 4 in the [Supplement](#)).

Discussion

This study of more than 24 000 HCP found a low SARS-CoV-2 seroprevalence of 4.4% across multiple, geographically diverse health care systems. Most prior studies worldwide on HCP seropositivity have been limited to 1 health care system or region.^{1-6,14} Our rate of SARS-CoV-2 seropositivity was similar to that found in some health care centers^{3,4} but substantially lower than others.⁶ In our study, there was no clear association between workplace contact with patients with COVID-19 and antibody positivity, consistent with some studies^{1,5} but conflicting with others.^{2,3} We found that having community contact with COVID-19 increased the risk of being seropositive, similar to another study.¹

While prior studies assessed community exposure primarily through self-reporting, our study found an association between cumulative incidence of COVID-19 in an HCP's residential zip code and seropositivity across a diverse geographic area. We found that the higher the cumulative incidence of COVID-19 until the week prior to the antibody test, the higher the risk of the HCP being antibody positive. This finding aligns well with the observed association that HCP who had contact with a person with COVID-19 in the community were more likely to be antibody positive. Together, these findings suggest that exposures outside of the workplace, rather than exposures to patients with COVID-19, may be major drivers for SARS-CoV-2 infection among HCP in the United States.

A large study in Denmark that included more than 29 000 HCP found that HCP had a higher positivity rate than a contemporaneous comparison group of blood donors and that frontline HCP and HCP with more hospital exposure to COVID-19 patients had a higher risk.² Another study across 7 hospitals in Denmark tested more than 25 000 HCP and found a positivity rate of 3.4%, with higher positivity among HCP taking care of patients or working in the emergency department.³ However, similar to our study, a large study of more than 40 000 HCP in New York found no association

between work location or direct patient care and seropositivity but did not distinguish workplace and community exposures to individuals with known COVID-19.⁶

Although our study does not eliminate the possibility that workplace exposure to patients with COVID-19 increases the risk of SARS-CoV-2 infection, our findings suggest that for HCP, the risk of SARS-CoV-2 infection from community exposures may exceed the risk from patient exposures, especially considering that these findings were estimated across diverse geographic areas and health care systems. Although we were not able to assess chains of transmission in this study, it is possible that some HCP infections in the workplace were acquired during interactions in non-patient care settings, such as break rooms with other HCP with unknown SARS-CoV-2 infection. This has important implications for strategies for HCP protection. While education to HCP has focused on minimizing patient-to-HCP transmission of SARS-CoV-2, with significant effort appropriately expended to optimize patient triage, testing, and correct use of personal protective equipment, our findings suggest that additional effort is needed to prevent exposures in the community and possible workplace transmission between HCP to preserve the HCP workforce.

Recent data suggest that nurses are among the most common HCP infected with SARS-CoV-2,¹⁵ but this likely reflects workforce demographic characteristics given that nursing is the most common health care role.¹⁶ We did not find that certain job roles, including those with prolonged patient contact, such as nursing roles, had increased risk, even though nurses represented the largest portion of seropositive HCP across all job roles in our study. Importantly, these findings suggest that current infection control measures are effective for preventing SARS-CoV-2 transmission when working with patients, and HCP risk of infection may be driven by community and nonpatient care occupational exposures. Prioritizing efforts to practice optimal infection prevention in all health care facilities remains critical to keeping HCP and patients safe and may need to include assessments comparing transmission from patient-to-HCP and between HCP.

Vaccination will be important for minimizing SARS-CoV-2 infection among HCP. Despite similar levels of COVID-19 risk to non-HCP,¹⁴ HCP remain a priority group for vaccination for multiple reasons, including their continual potential exposures in the workplace, the importance of preserving health care capacity, and the risk of transmitting the virus from infected HCP to a large number of at-risk patients.¹⁵ Our findings suggest that COVID-19 vaccination and other prevention strategies targeting community transmission will also be critical to prevent SARS-CoV-2 infections in HCP.

Like previous US studies,^{4,8,9} we found that Black race was associated with seropositivity, consistent with existing health disparities in the community. Our analyses suggest that the association of Black race with SARS-CoV-2 seropositivity may be owing to existing disparities in community exposure rather than from health care-associated exposures. Surprisingly, we did not find an association between seropositivity and ethnicity, but this assessment was limited by the small number of Hispanic HCP in our study. While most previous serosurveys among HCP have not shown an association between age and SARS-CoV-2, we found that being younger than 30 years, a feature of nearly 20% of our HCP, had slightly increased risk of seropositivity. Younger HCP may be more likely to congregate in groups socially, have children in school or daycare, and have contact with other younger persons who may have fewer symptoms with infection. COVID-19 incidence was also observed to be highest among this US age group during the summer months.¹⁷

Limitations

This study has important limitations. Participants were HCP who volunteered for serology testing and thus represent a convenience sample. Laboratory methods differed across sites, potentially resulting in different overall positivity rates than would have been estimated if methods had been standardized. Questionnaires used at each site were not standardized; however, we were able to successfully map many domains. Risk factors included in our multivariable model were limited to those we were able to map from all sites. For example, we were unable to assess risk associated with participation in aerosol-generating procedures because these data were only available from 3 of the 4 health care system surveys. Because infection control practices were not standardized across all

sites and the practices changed during the study period (eTable 5 in the [Supplement](#)), we did not assess the association of specific infection control practices with seropositivity rates; however, we did observe similar HCP seropositivity rates despite institutional differences in personal protective equipment guidelines. In addition, we were unable to assess risk associated with exposure to an HCP with SARS-CoV-2 infection in the workplace because not all sites asked about such exposures. Furthermore, this study included predominately metropolitan HCP in acute care settings, and results may not be applicable to other health care settings, such as HCP in long-term care.

Conclusions

Using data from across health care systems and states, this cross-sectional study found that the factors presumed to be most associated with SARS-CoV-2 infection risk among HCP, including workplace role, environment, and caring for COVID-19 patients, were not associated with increased HCP risk of SARS-CoV-2 infection. These findings provide reassurance that current infection prevention practices in similar health care systems are effective and that the largest risks may be conferred from community-based exposures. Continued efforts to minimize SARS-CoV-2 infection risk among HCP will require more detailed investigation into the specific context surrounding workplace-acquired infections among HCP and emphasis on mitigating risk outside the health care setting, including vaccine considerations and potential community-based health disparities by race among HCP.

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Corresponding Author: Jesse T. Jacob, MD, School of Medicine, Emory University, 550 Peachtree St NE, Orr Bldg #1018, Atlanta, GA 30308 (jtjacob@emory.edu).

Author Affiliations: School of Medicine, Emory University, Atlanta, Georgia (Jacob, Fridkin, Steinberg); Rollins School of Public Health, Emory University, Atlanta, Georgia (Jacob, Baker, Fridkin, Lopman); University of Maryland School of Medicine, Baltimore (Christenson, King, Leekha, O'Hara, P. Rock, Schrank, Harris); Rush University Medical Center, Chicago, Illinois (Hayden, Hota, Lin, Stein); Johns Hopkins University School of Medicine, Baltimore, Maryland (Caturegli, Milstone, C. Rock, Voskertchian); US Centers for Disease Control and Prevention, Atlanta, Georgia (Reddy).

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Concept and design: Jacob, Baker, Fridkin, Lopman, Steinberg, Christenson, King, Schrank, Hayden, Lin, Milstone, C. Rock, Harris.

Acquisition, analysis, or interpretation of data: Jacob, Baker, Fridkin, Lopman, Steinberg, Leekha, O'Hara, P. Rock, Schrank, Hayden, Hota, Lin, Stein, Caturegli, Milstone, C. Rock, Voskertchian, Reddy, Harris.

Drafting of the manuscript: Jacob, Baker, Fridkin, Christenson, P. Rock, Harris.

Critical revision of the manuscript for important intellectual content: Jacob, Baker, Fridkin, Lopman, Steinberg, King, Leekha, O'Hara, Schrank, Hayden, Hota, Lin, Stein, Caturegli, Milstone, C. Rock, Voskertchian, Reddy, Harris.

Statistical analysis: Baker, O'Hara, Hota, Caturegli.

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SUPPLEMENT.

eTable 1. Mapping of 3 Metadata Variables From Site-Specific Surveys From 4 Health Care Systems

eFigure 1. Mean and Range for Cumulative Incidence of COVID-19 per 10 000 Among Study Participants Until 1 Week Prior to Serology Testing

eTable 2. Results of Logistic Regression Analyses Excluding Data from Emory, With SARS-CoV-2 Serology as the Outcome Variable

eTable 3. Results of Logistic Regression Analyses Including a Time Component (Month) in the Model, With SARS-CoV-2 Serology as the Outcome Variable

eTable 4. Results of Logistic Regression Analyses Excluding the Random Intercept Component, With SARS-CoV-2 Serology as the Outcome Variable

eTable 5. Infection Prevention Practices for Health Care Personnel (HCP) at the 4 Participating Health Care Systems Before (Cells Shaded Yellow) and During or After (Cells Shaded Blue) the Start of Seroprevalence Testing in HCP at That Site



COVID-19

Risk for COVID-19 Infection, Hospitalization, and Death By Age Group

Updated Sept. 9, 2021 [Print](#)

Rate compared to 18-29 years old ¹	0-4 years old	5-17 years old	18-29 years old	30-39 years old	40-49 years old	50-64 years old	65-74 years old	75-84 years old	85+ years old
Cases²	<1x	1x	Reference group	1x	1x	1x	1x	1x	1x
Hospitalization³	<1x	<1x	Reference group	2x	2x	4x	5x	9x	15x
Death⁴	<1x	<1x	Reference group	4x	10x	30x	90x	220x	570x

All rates are relative to the 18- to 29-year-old age category. This group was selected as the reference group because it has accounted for the largest cumulative number of COVID-19 cases compared to other age groups. Sample interpretation: Compared with 18- to 29-year-olds, the rate of death is four times higher in 30- to 39-year-olds, and 570 times higher in those who are 85 years and older. (In the table, a rate of 1x indicates no difference compared to the 18- to 29-year-old age category.)

References

¹ Rates are expressed as whole numbers, with values less than 10 rounded to the nearest integer, two-digit numbers rounded to nearest multiple of five, and numbers greater than 100 rounded to two significant digits.

² Includes all cases reported by state and territorial jurisdictions (through August 17, 2021, accessed on August 18, 2021). The denominators used to calculate rates were based on the 2019 [Vintage population](#) [link](#).

³ Includes all hospitalizations reported through [COVID-NET](#) (from March 1, 2020 through August 7, 2021, accessed on August 18, 2021). Rates were standardized to the 2020 US standard COVID-NET catchment population.

⁴ Includes all deaths in National Center for Health Statistics (NCHS) [provisional death counts](#) (through August 7, 2021, accessed on August 18, 2021). The denominators used to calculate rates were based on the 2019 Vintage population estimates.

Last Updated Sept. 9, 2021



COVID-19

Risk of Severe Illness or Death from COVID-19

Racial and Ethnic Health Disparities

Updated Dec. 10, 2020

Why are some racial and ethnic minority groups disproportionately affected by COVID-19? The following [links](#) provide specific information about underlying health and social inequities that put many racial and ethnic minority groups at increased risk of getting sick, having more severe illness, and dying from COVID-19.

1. [Introduction](#)
2. [Risk of Exposure to COVID-19](#)
3. [Risk of Severe Illness or Death from COVID-19](#)
4. [Disparities in COVID-19 Illness](#)
5. [Disparities in COVID-19-Associated Hospitalizations](#)
6. [Disparities in COVID-19 Deaths](#)
7. [Unintended Consequences of COVID-19 Mitigation Strategies](#)
8. [What We Can Do to Move Towards Health Equity](#)

Some of the many inequities in social determinants of health that may increase risk of severe illness (such as hospitalization, intubation, and death) from COVID-19 include access to quality healthcare, general health status, education, economic stability, and many other factors that affect health risks and outcomes. Because of these and other inequities, people from some racial and ethnic minority groups are less likely to be vaccinated against COVID-19 than non-Hispanic White people. COVID-19 vaccination reduces the risk of COVID-19 and its potentially severe complications. Discrimination, which includes racism, shapes social and economic factors that put people at increased risk of severe COVID-19 illness.^{1,2,3,4,5} Unfortunately, discrimination exists in systems meant to protect well-being and health. For example, discrimination within the healthcare system may deter people from seeking or receiving timely testing, vaccination, and treatment for health concerns, including COVID-19.⁶

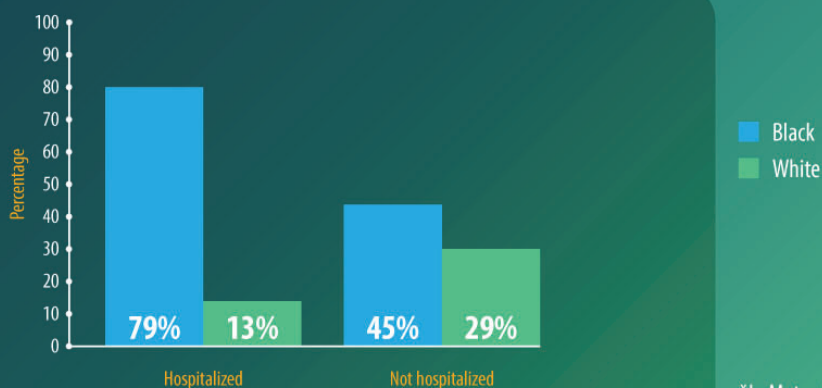
To explore additional information and data related to COVID-19 health and vaccination disparities, please visit the [Health Equity](#) and [Vaccine Equity](#) landing pages within the [CDC COVID Data Tracker](#).

Evidence for factors that contribute to risk for severe illness from COVID-19

Severe illness means that the person with COVID-19 requires hospitalization, intensive care, or a ventilator to help them breathe. Severe illness can lead to death. Among adults, the risk of severe illness from COVID-19 increases with age, with [older adults at highest risk](#). Additionally, people of any age, race, ethnicity, and sex with certain underlying medical conditions are at increased risk of severe illness from COVID-19. CDC continues to review the evidence and provide updates about the [underlying medical conditions that might increase risk of severe illness from COVID-19](#). More detailed [evidence summaries](#) are also available.

COVID-19 is a new disease. Currently, few studies have examined the social factors that increase risk of severe illness from COVID-19. However, these limited studies have found differences between racial and ethnic groups in the health and social factors that may increase risk of severe illness or death from COVID-19.⁷⁻²¹ Some of the studies are from the entire United States; others are from specific cities and communities. These studies consistently identify underlying factors that are associated with increased risk of severe illness from COVID-19. CDC will continue to monitor the latest evidence and provide updated information.

In Atlanta, black patients with COVID-19 were more likely to be hospitalized than white patients*



*In Metro Atlanta, March-April, 2020

The federal government, public health professionals, community organizations, healthcare systems and providers, and individuals can take action to reduce health disparities

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Text Description

Title:

In Atlanta, black patients with COVID-19 were more likely to be hospitalized than white patients*

Body of Graphic:

Y axis shows Percentage

X axis shows Hospitalized and Not hospitalized

Each racial/ethnic group has two vertical bars, different color—first color is blue for black persons, second color is green for white persons

Hospitalized: 79% black, 13% white

Not hospitalized: 45% black, 29% white

Bottom of graphic:

The federal government, public health professionals, community organizations, healthcare systems and providers, and individuals can take action to reduce health disparities

Footnote:

*In Metro Atlanta, March-April, 2020

Current evidence shows that the following factors are associated with increased risk of severe illness from COVID-19 for racial and ethnic minority groups:

- Healthcare:** A recent study found that people from racial and ethnic minority groups were more likely to have increased COVID-19 disease severity upon admission at the hospital compared with non-Hispanic White people.^{7,8,9,10} Healthcare access can also be limited for these groups by other factors, such as lack of transportation or child care, inability to take time off work, communication and language barriers, cultural differences between patients and providers, not having a usual source of care, and historical and current discrimination in healthcare systems.¹¹ Some people from racial and ethnic minority groups may hesitate to seek care because they distrust the government and healthcare systems. This distrust may be due to the roles of the government and healthcare systems in current inequities in treatment¹² and their responsibility for discriminatory, unethical, and abusive historical events. These historical events include the

Tuskegee Study, which studied intentionally untreated syphilis in non-Hispanic Black men without their knowledge, and the sterilization of racial and ethnic minority people without their knowledge or permission.^{13,14,15,16}

A recent study found that people from racial and ethnic minority groups were more likely to have increased COVID-19 disease severity upon admission at the hospital compared with non-Hispanic White people. More severe disease increased the likelihood that these patients would need intubation, be admitted to the Intensive Care Unit, or die.¹⁷ A separate study found that compared with non-Hispanic White people, non-Hispanic Black people were more likely to be hospitalized and were more likely to be tested for COVID-19 at a hospital than in the ambulatory (outpatient) setting. The researchers noted that the findings suggest non-Hispanic Black people may have delayed seeking care.¹⁸

- **General health status:** Underlying medical conditions that increase risk for severe illness from COVID-19 may be more common among people from racial and ethnic minority groups.¹⁹ Common underlying conditions among those who require mechanical ventilation or died included diabetes, high blood pressure, obesity, chronic kidney disease on dialysis, and congestive heart failure.²⁰ It is important to note that many of the same social determinants of health that increase risk of COVID-19 illness also increase the risk of health conditions such as obesity, high blood pressure, and diabetes. These specific social determinants of health include education, economic stability, and physical environment, and healthcare system factors (e.g., insurance coverage, access to care and treatment).

A study in New York City found that non-Hispanic Black and Hispanic or Latino people had higher obesity rates and higher COVID-19 mortality rates compared with non-Hispanic Asian and non-Hispanic White people.²¹ A study in Boston found that among patients hospitalized with COVID-19 at an urban medical center, non-Hispanic Black patients were more likely to have one or more underlying medical conditions than people from other racial or ethnic groups. In another study of patients hospitalized with COVID-19, non-Hispanic Black patients were more likely to have high blood pressure and diabetes compared with all other racial and ethnic groups combined.²² Another study found that among Black patients hospitalized with COVID-19, those with higher body mass index at arrival to the hospital were more likely to die.²³ Additionally, pregnant people may have an increased risk of severe illness from COVID-19.^{24,25} Given long-standing disparities in maternal health and birth outcomes,²⁶ it is important to consider how COVID-19 may affect these outcomes for people from racial and ethnic minority groups.

- **Education, income, and wealth gaps:** Inequities in access to high-quality education for people from racial and ethnic minority groups can lead to lower high school completion rates and barriers to college entrance.²⁷ This may limit future job options and lead to lower paying or less stable jobs. People with lower paying jobs often do not have paid sick leave and cannot afford to miss work, even if they're sick, because they would not be able to pay for essential items like food or other important living needs if their income decreased. Lower income is strongly associated with morbidity and mortality. Compared with non-Hispanic White people, American Indian, non-Hispanic Black, and Hispanic or Latino people have lower household incomes and shorter life expectancies, as well as higher rates of underlying medical conditions that increase risk of severe illness from COVID-19.^{28,29}

As of August 2020, more Hispanic or Latino people (53%) and non-Hispanic Black people (43%) reported that they had lost a job or taken a pay cut because of COVID-19 compared with non-Hispanic White people (38%). More non-Hispanic Black and Hispanic or Latino people, 40% and 43%, respectively, reported that they had to use money from savings or retirement to pay bills since the outbreak began, compared with 29% of non-Hispanic White people. Additionally, 43% of non-Hispanic Black people and 37% of Hispanic or Latino people reported having trouble paying their bills in full compared with non-Hispanic White people (18%).³⁰

To reduce the substantial toll COVID-19 has had on individuals and communities, we need to work together to address inequities in the social determinants of health that increase risk of severe illness from COVID-19 for racial and ethnic minority groups. We must also ensure that everyone has fair and just access to COVID-19 vaccination. Learn more about [what we can do to move towards health equity](#) and about what CDC is doing to address [COVID-19 Vaccine Equity for Racial and Ethnic Minority Groups \(cdc.gov\)](#).

Related Pages

- › [COVID-19 Health Equity – Promoting Fair Access to Health](#)
- › [CDC Social Determinants of Health: Know What Affects Health](#)
- › [Environmental Public Health Tracking Network](#) – Select “COVID-19” content area for options to view data on several factors related to increased risk of COVID-19

More information

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Robert Wood Johnson Foundation's 2020 County Health Ranking State Reports [↗](#)


National Association of County and City Health Officials' COVID-19 Resources for Local Health Departments [↗](#)


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the-hardest/ .

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Safe Care, Safe Workplace – We Are Vaccinated



September 27, 2021

by Janice E. Nevin, M.D., MPH, President & CEO

In late July, we made a commitment to put the safety of our caregivers and our patients first by requiring COVID-19 vaccination for everyone who works at ChristianaCare by September 21, 2021. Our organization has taken this important step to protect the safety of our caregivers, patients and community.



As we anticipated, a small number of caregivers

chose not to be vaccinated and have left the

organization. Separations for non-compliance

with our vaccination policy resulted in the loss of

approximately 150 employees, the equivalent of

fewer than 90 full-time employees. Of these, fewer

than 48 FTEs (full-time equivalents) provided direct patient care, and fewer

than 12 FTEs were nurses. Approximately 200 caregivers have received

religious or medical accommodations, and in addition to masking, these

caregivers will be required to undergo regular COVID-19 testing.



Janice Nevin, M.D., MPH

In the last month, our ongoing focus on workforce resulted in hiring more than 200 caregivers, including more than 160 positions that provide direct patient care. These new caregivers join an organization in which they can be confident that their colleagues are vaccinated and that their organization is a leader in COVID-19 safety.

We thank everyone who has made the decision to be vaccinated. Getting vaccinated is a service to others – especially our health care workers, who continue to battle COVID-19 daily as we meet the health care needs of our community. Vaccination continues to be our path not only to protect each other—but to ultimately reduce the spread of COVID-19 and end this pandemic.

Respiratory Therapist Kathleen Bonis was the first ChristianaCare caregiver to receive the COVID-19 vaccine. Tabe Mase, MSN, director of Employee Health, administered the first vaccination to her colleague.

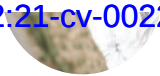
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Safety of COVID-19 Vaccines

Updated Oct. 12, 2021

[Print](#)


What You Need to Know

- COVID-19 vaccines are **safe and effective**.
- Millions of people in the United States have received COVID-19 vaccines under the most intense safety monitoring in U.S. history.
- CDC recommends you [get a COVID-19 vaccine](#) as soon as possible.
- If you are fully vaccinated, you can resume activities that you did prior to the pandemic. Learn more about what you can do [when you have been fully vaccinated](#).

Millions of People Have Safely Received a COVID-19 Vaccine

Over 403 million doses of COVID-19 vaccine have been given in the United States from December 14, 2020, through October 12, 2021.

COVID-19 vaccines are **safe and effective**. COVID-19 vaccines were evaluated in tens of thousands of participants in clinical trials. The vaccines met the Food and Drug Administration's (FDA) rigorous scientific standards for safety, effectiveness, and manufacturing quality needed to support approval or authorization of a vaccine.

Millions of people in the United States have received COVID-19 vaccines since they were authorized for emergency use by FDA. These vaccines have undergone and will continue to undergo the most intensive safety monitoring in U.S. history. This monitoring includes using both [established and new safety monitoring systems](#)  [\[PDF - 83 KB\]](#) to make sure that COVID-19 vaccines are safe.

Results Are Reassuring

Results from vaccine safety monitoring efforts are reassuring. Some people have no side effects. Others have reported common [side effects after COVID-19 vaccination](#), like

- swelling, redness, and pain at injection site
- fever
- headache
- tiredness
- muscle pain
- chills
- nausea

Serious Safety Problems Are Rare

To date, the systems in place to monitor the safety of these vaccines have found only two serious types of health problems after vaccination, both of which are rare. These are anaphylaxis and thrombosis with thrombocytopenia syndrome (TTS) after vaccination with J&J/Janssen COVID-19 Vaccine.

Anaphylaxis

A small number of people have had a [severe allergic reaction](#) (called “anaphylaxis”) after vaccination, but this is **rare**. Anaphylaxis can occur after any vaccination. If this occurs, vaccination providers have medicines available to effectively and immediately treat the reaction.

After you get a COVID-19 vaccine, you will be asked to stay for 15–30 minutes so you can be observed in case you have a severe allergic reaction and need immediate treatment.

Thrombosis with Thrombocytopenia Syndrome (TTS) after Vaccination with J&J/Janssen COVID-19 Vaccination

After receiving the J&J/Janssen COVID-19 Vaccine, there is risk for a rare but serious adverse event—blood clots with low platelets (thrombosis with thrombocytopenia syndrome, or TTS). Women younger than 50 years old should especially be aware of their increased risk for this rare adverse event. There are other COVID-19 vaccines available for which this risk has not been seen.

This adverse event is rare, occurring at a rate of about 7 per 1 million vaccinated women between 18 and 49 years old. For women 50 years and older and men of all ages, this adverse event is even more rare.

COVID-19

Second dose than after the first dose of one of the two mRNA COVID-19 vaccines, Pfizer-BioNTech or Moderna. These reports are rare and the known and potential benefits of COVID-19 vaccination outweigh the known and potential risks, including the [possible risk of myocarditis or pericarditis](#).

Long-Term Side Effects Are Unlikely

Serious side effects that could cause a long-term health problem are extremely unlikely following any vaccination, including COVID-19 vaccination. Vaccine monitoring has historically shown that side effects generally happen within six weeks of receiving a vaccine dose. For this reason, the FDA required each of the authorized COVID-19 vaccines to be studied for at least two months (eight weeks) after the final dose. Millions of people have received COVID-19 vaccines, and no long-term side effects have been detected.

CDC continues to closely monitor the safety of COVID-19 vaccines. If scientists find a connection between a safety issue and a vaccine, FDA and the vaccine manufacturer will work toward an appropriate solution to address the specific safety concern (for example, a problem with a specific lot, a manufacturing issue, or the vaccine itself).

Have you experienced a side effect following COVID-19 vaccination?

You can [report it to VAERS](#) [↗](#).

More Information

[ACIP COVID-19 Vaccines Safety Technical Sub-Group \(VaST\)](#)


[VaST Subgroup Technical Report](#)

RESEARCH

Open Access



SARS-Coronavirus-2 cases in healthcare workers may not regularly originate from patient care: lessons from a university hospital on the underestimated risk of healthcare worker to healthcare worker transmission

Sandra Schneider¹, Brar Piening¹, Pauline Assina Nouri-Pasovsky¹, Anne Caroline Krüger², Petra Gastmeier¹ and Seven Johannes Sam Aghdassi^{1*} 

Abstract

Background: Coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) represents an unprecedented healthcare challenge. Various SARS-CoV-2 outbreaks in healthcare facilities have been reported. Healthcare workers (HCWs) may play a critical role in the spread of the virus, particularly when asymptomatic. We examined four healthcare-associated outbreaks of SARS-CoV-2 infections that occurred at a university hospital in Berlin, Germany. We aimed to describe and analyze the spread of the virus in order to draw conclusions for effective containment of SARS-CoV-2 in healthcare facilities.

Methods: Healthcare-associated outbreaks of SARS-CoV-2 infections were defined as two or more laboratory confirmed infections with SARS-CoV-2 where an epidemiological link within the healthcare setting appeared likely. We focused our analysis on one of three sites of the Charité-University Medicine hospital within a 2 month period (March and April 2020).

Results: We observed four healthcare-associated outbreaks of SARS-CoV-2 infections, with a total of 24 infected persons (23 HCWs and one patient). The outbreaks were detected in the departments of nephrology and dialysis (n = 9), anesthesiology (n = 8), surgical pediatrics (n = 4), and neurology (n = 3). Each outbreak showed multiple unprotected contacts between infected HCWs. A combination of contact tracing, testing, physical distancing and mandatory continuous wearing of face masks by all HCWs was able to contain all four outbreaks.

*Correspondence: seven-johannes-sam.aghdassi@charite.de

¹ Institute of Hygiene and Environmental Medicine, Charité-Universitätsmedizin Berlin, corporate member of Freie Universität Berlin, Humboldt-Universität zu Berlin, and Berlin Institute of Health, Berlin, Germany

Full list of author information is available at the end of the article



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Conclusions: HCW to HCW transmission represented the likely source of the four outbreaks. Ensuring proper physical distancing measures and wearing of protective equipment, also when interacting with colleagues, must be a key aspect of fighting COVID-19 in healthcare facilities.

Keywords: SARS-Coronavirus-2, COVID-19, Outbreak, Healthcare-associated infection, Occupational health, Infection control

Background

In December 2019, first reports emerged from Wuhan, China about a cluster of pneumonias with a suspected epidemiological link to a seafood wholesale market [1]. The underlying pathogen was identified and provisionally named 2019 novel coronavirus [2]. The virus was later renamed by the International Committee on Taxonomy of Viruses as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [3]. The disease caused by SARS-CoV-2 was named coronavirus disease 2019 (COVID-19) by the World Health Organization [4]. In late January 2020, the first infection with SARS-CoV-2 was detected in Germany, presumably linked to contact with a Chinese business traveler [5]. First cases of local transmission in Germany were noted in late February 2020 [6]. On 1 March 2020 the first case of COVID-19 in Berlin was confirmed [7]. Due to the accelerated spread of the disease, several measures were implemented in Germany, and Berlin specifically. Strict social distancing measures were set up and gatherings of more than two people were prohibited on 22 March 2020 [8]. Hospitals had to reduce the number of visitors to a minimum.

Droplets have been described as the main vector for human-to-human transmission of SARS-CoV-2 [9]. Asymptomatic infection and spread of the virus by pre-symptomatic or asymptomatic carriers have been reported in the early stages of the global outbreak [5]. Healthcare workers (HCWs) infected or colonized with pathogens pose a challenge in the practice of infection prevention and represent a potential source for healthcare-associated outbreaks [10, 11]. Multiple healthcare-associated clusters with SARS-CoV-2 have been reported [12, 13]. Commonly, infected patients are regarded as the biggest risk with regards to pathogen transmission for both other patients and HCWs. However, asymptotically infected personnel can represent a complicating factor in the context of SARS-CoV-2 outbreaks in healthcare facilities [14, 15], and may be an underestimated risk for patient and HCW safety.

In this article, we report and examine four healthcare-associated outbreaks of SARS-CoV-2 infections that occurred at one of the sites of a university hospital in Berlin, Germany. We aim to describe and analyze the spread of the virus to draw conclusions for the effective containment of SARS-CoV-2 in healthcare facilities.

Methods

Charité-University Medicine Berlin is a large tertiary care university hospital with three separate sites and more than 3000 beds. As a first response to the spread of the COVID-19 epidemic in China, the hospital required all return travelers from China to abstain from any activities at the hospital (i.e. patient care or any other kind of work at the hospital) and recommended isolation at home for 14 days. This regulation was put into effect on 14 February 2020, and subsequently extended to other risk areas (i.e. countries or other areas of the world with assumed widespread community-transmission of SARS-CoV-2 as defined by the German Robert Koch-Institute) as the spread of the disease continued. Reverse transcriptase polymerase chain reaction (RT-PCR) testing for SARS-CoV-2 was offered to all return travelers and explicitly recommended for those showing signs of infection. On 1 March 2020 the first COVID-19 patient was hospitalized at Charité's Virchow campus. Personal protective equipment (PPE) recommended by Charité's infection prevention and control (IPC) team for the care of COVID-19 patients consisted of a medical face mask, gloves and gowns, and in case of exposure to aerosols, of a filtering facepiece mask 2 or 3 (FFP2, FFP3) plus goggles or a face shield. On 3 March 2020 an outpatient SARS-CoV-2 RT-PCR-testing facility was opened at the Virchow campus. Designated testing sites for employees were established at all three campuses on 17 March 2020. Tests were analyzed in the routine laboratory work. Sampling for SARS-CoV-2 testing was done by a combined oro- and nasopharyngeal swab.

Continuous surveillance of SARS-CoV-2 was initiated in the beginning of March 2020. New cases of laboratory confirmed SARS-CoV-2 infections among patients and HCWs were evaluated by the IPC team. Contact persons, both patients and staff, with relevant exposure to infected individuals were identified. Contact tracing was conducted for a period of 48 h prior to the onset of symptoms, or 48 h before sample collection in case of asymptomatic infections. The definitions applied for contact tracing were oriented towards the SARS-CoV-2 contact categories by the German Robert Koch-Institute [16]. Contacts to SARS-CoV-2 positive persons were regarded as relevant for contact tracing if any of the following criteria applied:

- direct contact with potentially infectious body fluids (e.g. respiratory tract specimen) without proper PPE (patient to HCW contact),
- exposure to aerosols without proper PPE (patient to HCW contact),
- face-to-face contact under two meters without at least one person wearing a face mask (patient to patient, patient to HCW, HCW to patient and HCW to HCW contacts), or
- sharing the same patient room (patient to patient contact).

A healthcare-associated outbreak of SARS-CoV-2 infections was defined as two or more infections where an epidemiological link appeared likely, and where acquisition of the pathogen in the healthcare setting was assumed. Only laboratory-confirmed cases with a positive RT-PCR for SARS-CoV-2 were counted. We focused our analysis on the Virchow campus of the Charité-University Medicine hospital within a 2 month period (March and April 2020).

Hospitals in Germany are required by the German Protection against Infection Act to conduct continuous surveillance for healthcare-associated infections [17]. All data presented in this publication were collected in alignment with this regulation. Thus, ethical approval or informed consent were not necessary.

Results

Between 1 March and 30 April 2020 we detected four healthcare-associated outbreaks of SARS-CoV-2 infections, comprising of 24 infected persons (23 HCWs and one patient). The outbreaks occurred in the departments

of nephrology and dialysis (NEPH) (n=9), anesthesiology (ANAE) (n=8), surgical pediatrics (SPED) (n=4), and neurology (NEUR) (n=3).

Table 1 summarizes baseline characteristics and epidemiological key data of the NEPH outbreak. Case one was originally regarded as a single case that had returned from a vacation abroad on 15 March 2020, and that tested positive for SARS-CoV-2 2 days later. Case two was a relevant contact of case one and was tested positive for SARS-CoV-2 on 19 March 2020. As a result of the two positive tests, all relevant contacts and several other employees of the NEPH department underwent testing for SARS-CoV-2. Through this extensive testing, one patient and six other HCWs infected with SARS-CoV-2 were identified (cases 3–9 in Table 1). With the exception of case six, these all had relevant contact with either case one or two prior to the testing. None of the HCWs from the NEPH department had knowingly been involved in the treatment of COVID-19 patients before the outbreak. All patients with relevant contact to infected staff from the NEPH department were identified, isolated for 14 days after the last exposure and tested for SARS-CoV-2 if they were still hospitalized. Relevant contact patients already discharged, were immediately informed and instructed to isolate at home and contact health authorities if symptoms developed. No additional cases in the NEPH outbreak were noted after 23 March 2020.

Table 2 illustrates key data of the ANAE outbreak. Cases one and two were initially considered isolated cases. Reportedly, no contact occurred between the two individuals. Neither of them had knowingly been involved in the treatment of COVID-19 patients prior to the positive tests. On 30 March 2020 case three was

Table 1 Baseline characteristics and epidemiological key data of the SARS-Coronavirus-2 (SARS-CoV-2) outbreak in the department of nephrology and dialysis

Case number	Function	Onset of symptoms	Date of sample collection for SARS-CoV-2 test	Relevant contact ^a prior to onset of symptoms (or positive test if asymptomatic or unknown date of onset of symptoms)
1	Physician	15 March 2020	17 March 2020	None reported
2	Physician	18 March 2020	19 March 2020	Case 1
3	Physician	16 March 2020	20 March 2020	Cases 2, 9
4	Physician	21 March 2020	21 March 2020	Case 2
5	Patient	Unknown	23 March 2020	Case 2
6	Medical student	Unknown	23 March 2020	None reported
7	Medical student	Unknown	23 March 2020	Case 2
8	Nurse	Asymptomatic	23 March 2020	Cases 1, 4, 5
9	Physician	Asymptomatic	23 March 2020	Case 2

^a Relevant contact was defined as direct contact with potentially infectious body fluids (e.g. respiratory tract specimen) without proper personal protective equipment (PPE) (patient to healthcare worker (HCW) contact), or exposure to aerosols without proper PPE (patient to HCW contact), or face-to-face contact under two meters without at least one person wearing a face mask (patient to patient, patient to HCW, HCW to patient and HCW to HCW contacts), or sharing the same patient room (patient to patient contact)

Table 2 Baseline characteristics and epidemiological key data of the SARS-Coronavirus-2 (SARS-CoV-2) outbreak in the department of anaesthesiology

Case number	Function	Onset of symptoms	Date of sample collection for SARS-CoV-2 test	Relevant contact ^a prior to onset of symptoms (or positive test if asymptomatic or unknown date of onset of symptoms)
1	Nurse	Asymptomatic	20 March 2020	None reported
2	Physician	19 March 2020	23 March 2020	None reported
3	Physician	Unknown	30 March 2020	Case 4 of the nephrology outbreak
4	Physician	Unknown	3 April 2020	Case 3
5	Physician	31 March 2020	3 April 2020	None reported
6	Nurse	Asymptomatic	3 April 2020	Case 1
7	Nurse	Unknown	5 April 2020	Case 4
8	Nurse	Asymptomatic	6 April 2020	None reported

^a Relevant contact was defined as direct contact with potentially infectious body fluids (e.g. respiratory tract specimen) without proper personal protective equipment (PPE) (patient to healthcare worker (HCW) contact), or exposure to aerosols without proper PPE (patient to HCW contact), or face-to-face contact under two meters without at least one person wearing a face mask (patient to patient, patient to HCW, HCW to patient and HCW to HCW contacts), or sharing the same patient room (patient to patient contact)

identified. Case three had been in direct contact (face-to-face contact without a face mask) with case number four of the NEPH outbreak. After identification of case three, all personnel that had been in contact with any of the first three cases of the ANAE outbreak, and several other employees of the ANAE department were tested for SARS-CoV-2. Through this process, five additional infections with SARS-CoV-2 were identified. Three of which (cases 4, 6, 7 in Table 2) reported having had relevant contact with other SARS-CoV-2 positive staff prior to testing. No nosocomial SARS-CoV-2 infections of patients occurred in the ANAE department, and no patients had been exposed to any of the infected HCWs without HCWs wearing medical masks. Cases 3, 4, 7, 8 worked in wards, in which COVID-19 patients or suspected cases were treated during the time of the outbreak. No contacts to COVID-19 patients without PPE were reported by any of the infected HCWs. The last case of the ANAE outbreak was recorded on 6 April 2020.

The SPED outbreak which consisted of four HCWs is displayed in Table 3. Case one was initially considered as an isolated case. After detection of case one, all relevant contact patients and employees were identified. Contact staff underwent testing for SARS-CoV-2. Contact patients still hospitalized were isolated for 14 days after the last exposure and tested for SARS-CoV-2. Patients already discharged, were informed and instructed to home isolate and contact health authorities if symptoms appeared. While none of the contact patients tested positive for SARS-CoV-2, three additional HCWs were identified by the extensive testing. Two of which (cases 2, 4 in Table 3) had been in relevant contact with case one prior to testing. None of the HCWs that tested positive for SARS-CoV-2 reported having been involved in the treatment of COVID-19 patients prior to testing. The last case of the SPED outbreak was detected on 3 April 2020.

Details of the NEUR outbreak that consisted of three HCWs infected with SARS-CoV-2 are summarized in Table 4. Cases one and two tested positive for

Table 3 Baseline characteristics and epidemiological key data of the SARS-Coronavirus-2 (SARS-CoV-2) outbreak in the department of surgical paediatrics

Case number	Function	Onset of symptoms	Date of sample collection for SARS-CoV-2 test	Relevant contact ^a prior to onset of symptoms (or positive test if asymptomatic or unknown date of onset of symptoms)
1	Physician	9 March 2020	23 March 2020	None reported
2	Physician	25 March 2020	25 March 2020	Case 1
3	Nurse	27 March 2020	29 March 2020	None reported
4	Nurse	31 March 2020	3 April 2020	Case 1

^a Relevant contact was defined as direct contact with potentially infectious body fluids (e.g. respiratory tract specimen) without proper personal protective equipment (PPE) (patient to healthcare worker (HCW) contact), or exposure to aerosols without proper PPE (patient to HCW contact), or face-to-face contact under two meters without at least one person wearing a face mask (patient to patient, patient to HCW, HCW to patient and HCW to HCW contacts), or sharing the same patient room (patient to patient contact)

Table 4 Baseline characteristics and epidemiological key data of the SARS-Coronavirus-2 (SARS-CoV-2) outbreak in the department of neurology

Case number	Function	Onset of symptoms	Date of sample collection for SARS-CoV-2 test	Relevant contact ^a prior to onset of symptoms (or positive test if asymptomatic or unknown date of onset of symptoms)
1	Physician	13 March 2020	14 March 2020	None reported
2	Physician	14 March 2020	15 March 2020	Case 1
3	Physician	23 March 2020	30 March 2020	Case 1

^a Relevant contact was defined as direct contact with potentially infectious body fluids (e.g. respiratory tract specimen) without proper personal protective equipment (PPE) (patient to healthcare worker (HCW) contact), or exposure to aerosols without proper PPE (patient to HCW contact), or face-to-face contact under two meters without at least one person wearing a face mask (patient to patient, patient to HCW, HCW to patient and HCW to HCW contacts), or sharing the same patient room (patient to patient contact)

SARS-CoV-2 on consecutive days and had been in relevant contact in the days before. A third HCW with relevant contact to case one developed discreet symptoms of a respiratory tract infection and tested positive for SARS-CoV-2. Following the detection of the third case, staff with relevant contact to any of the cases underwent testing for SARS-CoV-2. Contact patients that were still hospitalized were isolated for 14 days after the last exposure and tested for SARS-CoV-2. Patients that were already discharged were instructed to isolate at home and contact health authorities in case symptoms developed. Testing of contact persons did not reveal any additional cases. The last case of the NEUR outbreak was detected on 30 March 2020.

In all four outbreaks, positive HCWs were exempt from work and sent into quarantine at home. Contact staff were allowed to continue working, but were instructed to closely monitor their health and continuously wear a face mask when in contact with patients or other personnel. In case of symptoms developing, contact HCWs were instructed to leave work immediately and undergo testing for SARS-CoV-2. The requirement to continuously wear a face mask was extended from contact staff to all HCWs in the hospital on 25 March 2020. All meetings had to be reduced to the minimum number of people necessary. Furthermore, HCWs were instructed to practice physical distancing during breaks and take meals separately. The public health authorities were notified of all four outbreaks. Outbreaks were considered contained if for a period of 28 days no new cases were noted. For all four outbreaks this was achieved.

Discussion

Four outbreaks of SARS-CoV-2 infections in four different departments emerged at our campus within a short period of time. Two of the four outbreaks (NEPH and ANAE) were interlinked. With the exception of one patient in the NEPH outbreak, all infections occurred in HCWs. As the primary finding of our investigation we

therefore conclude that HCW to HCW transmission can represent a critical factor in the spread of SARS-CoV-2 outbreaks in hospitals and may in some cases outweigh the risks posed by infected patients.

Interactions between HCWs in the hospital setting are frequent and an important aspect of a functioning team [18]. Physical distancing requires people to interact less or remotely and increase space between individuals [19]. The importance of physical distancing in the context of containment and mitigation of COVID-19 and other outbreaks has repeatedly been demonstrated [20, 21]. Despite heightened public awareness of the matter, our findings suggest that social interactions in our hospital initially continued without ensuring sufficient physical distancing. We consider the fact that the observed outbreaks almost exclusively consisted of HCWs and the multiple contacts between infected HCWs that were reported, a strong indicator that a majority of the observed SARS-CoV-2 infections were due to HCW to HCW transmission. This finding highlights the importance of incorporating a culture change towards strict physical distancing among colleagues, when not wearing a medical mask, into the practice of medicine during the time of the COVID-19 pandemic. Reports from other SARS-CoV-2 outbreaks in healthcare facilities that predominantly affected staff, reinforce this impression [15]. Molecular typing of the SARS-CoV-2 strains isolated from the infected individuals was not routinely performed at the time of the respective outbreaks and outbreak management was primarily focused on direct mitigation measures. As a result, meticulous reconstructions of chains of infections was not possible with the data available. Despite this limitation, we believe that the observed epidemiological constellation along with the decrease in cases after appropriate mitigation measures had been established, affirm our hypothesis of HCW to HCW transmission.

Steadily wearing a face mask can help reduce the spread of pathogens, including SARS-CoV-2 [22–24]. We believe

that the most effective measure against the spread of SARS-CoV-2 at our campus was the decision to require all HCWs to continuously wear a medical face mask. This regulation did not only apply to direct patient care, but also to interactions with colleagues. It is remarkable that the large NEPH outbreak did not see any additional cases after the regulation to continuously wear face masks was put into practice on 25 March 2020. While cases occurred in the ANAE and SPED outbreaks after the regulation was established, daily observations indicated that incorporation of this new regulation into daily practice was not instantaneous, but took some time. Therefore, it is possible that some of the infections observed in the ANAE and SPED outbreaks that became apparent after 25 March, may have been acquired either before the date or during the “wash-in” period of universal face mask use. Another aspect that supports this interpretation is that no new outbreaks at our campus occurred during the observed period after the regulation to continuously wear face masks was put into effect.

Another observation was that unprotected contacts between HCWs often occurred in lunch and smoker breaks or in office situations, where masks were taken off and the physical distance between people was overestimated. The hospital IPC team frequently addressed this issue and emphasized the importance of continuous face mask wearing in office situations and recommended spending breaks and taking meals separately. Rising case numbers of SARS-CoV-2, both in the community and specifically among employees, might have also increased awareness on the matter and thereby facilitated adoption of mitigation measures by HCWs.

An aspect of similar importance for containing all four outbreaks was the identification and testing of personnel that had been exposed to SARS-CoV-2 carriers. Especially in the early stages of an outbreak it is crucial to quickly gain an overview about the number of cases. In this context, the long lag between the onset of symptoms and the testing of case one of the SPED cluster is noteworthy. Although speculative, it is conceivable that the other infections of the SPED cluster might have been avoided had case one been identified as SARS-CoV-2-positive sooner. The existence of a designated, readily accessible testing site for staff can facilitate rapid and systematic screening of HCWs. We believe that the employee testing site that commenced its operations on 17 March 2020 at our campus, was a key tool for successful outbreak management.

Various limitations have to be acknowledged when interpreting our findings. The COVID-19 pandemic is a dynamic situation with community-transmission occurring almost in all parts of the world. Therefore and due to the fact that molecular typing of the isolated

SARS-CoV-2 strains was not performed, it is possible that some infections that were counted as part of the nosocomial clusters occurred outside the healthcare setting. Undetected SARS-CoV-2 infections among patients might have represented another source of infection. If such patients had been treated at our campus, it would have been possible that HCWs might have acquired the virus from patients rather than other HCWs. To the best of our knowledge, however, no such cases of undetected HCW exposure to COVID-19 patients occurred during the time of the reported outbreaks. Although the outbreak management was carried out in a sensitive and blame-free manner, some questions related to it may have been perceived as potentially compromising by some of the affected HCWs. Thus, not admitting to not using proper PPE or not acknowledging other unprotected contacts cannot be ruled out. Due to the possibility of false negative SARS-CoV-2 tests and the fact that not all HCWs in the entire hospital were tested, cases of SARS-CoV-2 infections in HCWs and potentially even outbreaks in other departments may have been missed. Compliance with measures, such as mandatory and universal wearing of face masks, might have varied between individuals. Therefore, the effect of such measures should be assessed with caution.

Conclusions

PPE places a focus on protecting HCWs from infected patients. Undoubtedly, this represents a key aspect of reducing the spread of SARS-CoV-2 and maintaining HCWs' health. The threat of infection from colleagues, however, might be underestimated by many HCWs. Increasing awareness of this potential source of infection, i.e. ensuring proper physical distancing measures and wearing of protective equipment when interacting with colleagues, must be a primary focus of infection prevention strategies in times of the COVID-19 pandemic. Since transmission of SARS-CoV-2 by asymptotically infected individuals is possible, this aspect gains additional relevance.

Abbreviations

ANAE: Anesthesiology; COVID-19: Coronavirus disease 2019; HCW: Healthcare worker; IPC: Infection prevention and control; NEPH: Nephrology and dialysis; NEUR: Neurology; PPE: Personal protective equipment; RT-PCR: Reverse transcriptase polymerase chain reaction; SARS-CoV-2: Severe acute respiratory syndrome coronavirus 2; SPED: Surgical pediatrics.

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Authors' contributions

S. Schneider, B. Piening, P. Nouri-Pasovsky, P. Gastmeier and S. Aghdassi were in charge of the management of all four outbreaks described in this study. S.

Schneider, P. Gastmeier and S. Aghdassi determined the scope of the article. A. Krüger contributed important details to the results part of the article. S. Schneider and S. Aghdassi drafted the manuscript with the input of all co-authors. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Ethics approval and consent to participate

Not applicable, because all data were surveillance-based data which were obtained in accordance with the German Protection against Infection Act.

Consent for publication

Not applicable, because all data were surveillance-based data which were obtained in accordance with the German Protection against Infection Act.

Competing interests

The authors declare that they have no competing interests.

Author details

¹ Institute of Hygiene and Environmental Medicine, Charité-Universitätsmedizin Berlin, corporate member of Freie Universität Berlin, Humboldt-Universität zu Berlin, and Berlin Institute of Health, Berlin, Germany. ² Department of Nephrology and Medical Intensive Care, Charité-Universitätsmedizin Berlin, corporate member of Freie Universität Berlin, Humboldt-Universität zu Berlin, and Berlin Institute of Health, Berlin, Germany.

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COVID-19

Science Brief: COVID-19 Vaccines and Vaccination

Updated Sept. 15, 2021

Summary of Recent Changes

Last updated September 15, 2021



- Data were added indicating that COVID-19 vaccination remains highly effective against COVID-19 hospitalization and death caused by the Delta variant of SARS-CoV-2.
- Data were added from studies published since the last update that further characterize reduced COVID-19 vaccine effectiveness against asymptomatic and mild symptomatic infections with the Delta variant of SARS-CoV-2.
- Data were added from studies published since the last update that suggest decreased vaccine effectiveness against SARS-CoV-2 infection, symptomatic disease, and hospitalization in several groups of immunocompromised persons and potential benefit of a third dose of COVID-19 vaccine in immunocompromised populations.
- Data were added summarizing several small studies of heterologous COVID-19 vaccination series (i.e., mixed schedules), which found that a dose of adenovirus vector vaccine followed by a dose of mRNA vaccine elicits antibody responses at least as high as two doses of mRNA vaccine.
- Data were added from recent studies examining the duration of protection conferred by COVID-19 vaccination.
- Data were added from recent studies describing clinical outcomes and transmissibility of SARS-CoV-2 infections in fully vaccinated persons.

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Key Points

- All COVID-19 vaccines currently approved or authorized in the United States (Pfizer-BioNTech/Comirnaty, Moderna, and Janssen [Johnson & Johnson]) are effective against COVID-19, including against severe disease, hospitalization, and death.
- Available evidence suggests the currently approved or authorized COVID-19 vaccines are highly effective against hospitalization and death for a variety of strains, including Alpha (B.1.1.7), Beta (B.1.351), Gamma (P.1), and Delta (B.1.617.2); data suggest lower effectiveness against confirmed infection and symptomatic disease caused by the Beta, Gamma, and Delta variants compared with the ancestral strain and Alpha variant. Ongoing monitoring of vaccine effectiveness against variants is needed.
- Limited available data suggest lower vaccine effectiveness against COVID-19 illness and hospitalization among immunocompromised people. In addition, numerous studies have shown reduced immunologic response to COVID-19 vaccination among people with various immunocompromising conditions.
- The risk for SARS-CoV-2 infection in fully vaccinated people cannot be completely eliminated as long as there is continued community transmission of the virus. Early data suggest infections in fully vaccinated persons are more commonly observed with the Delta variant than with other SARS-CoV-2 variants. However, data show fully vaccinated persons are less likely than unvaccinated persons to acquire SARS-CoV-2, and infections with the Delta variant in fully

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vaccinated persons are associated with less severe clinical outcomes. Infections with the Delta variant in vaccinated persons potentially have reduced transmissibility than infections in unvaccinated persons, although additional studies are needed.

- This updated science brief synthesizes the scientific evidence supporting CDC's [guidance for fully vaccinated people](#) and will continue to be updated as more information becomes available.

Background

COVID-19 vaccination is a critical prevention measure to help end the COVID-19 pandemic. COVID-19 vaccines are now widely available in the United States, and CDC recommends all people 12 years and older be vaccinated against COVID-19.

On August 23, 2021, the U.S. Food and Drug Administration (FDA) approved an mRNA vaccine (Pfizer-BioNTech/Comirnaty) as a 2-dose series for prevention of symptomatic COVID-19 in persons aged ≥ 16 years. This vaccine is also authorized under an Emergency Use Authorization (EUA) to be administered to prevent COVID-19 in persons aged 12-15 years. A second mRNA vaccine (Moderna), as well as a recombinant, replication-incompetent adenovirus serotype 26 (Ad26) vector vaccine (Janssen vaccine [Johnson & Johnson]) are authorized under an EUA for use in persons aged ≥ 18 years. Both mRNA vaccines are also authorized for administration of an additional dose to certain immunocompromised persons.

People are considered fully vaccinated if they are ≥ 2 weeks following receipt of the second dose in a 2-dose series (mRNA vaccines), or ≥ 2 weeks following receipt of a single-dose vaccine (Janssen vaccine).*

Public health recommendations for people fully vaccinated with FDA-approved or FDA-authorized COVID-19 vaccines consider evidence of vaccine effectiveness against symptomatic COVID-19 with and without severe outcomes, as well as vaccine impact on SARS-CoV-2 transmission. Other individual and societal factors are also important when evaluating the benefits and potential harms of additional prevention measures (e.g., masking, physical distancing) among vaccinated individuals. The Advisory Committee on Immunization Practices and CDC routinely consider individual health benefits and risks along with factors such as population values, acceptability, and feasibility of implementation when making vaccine recommendations.⁽¹⁾ These factors were also considered when developing CDC's [interim public health recommendations for fully vaccinated people](#).

In this scientific brief, we summarize evidence available through August 24, 2021, for the currently approved or authorized COVID-19 vaccines (administered according to the recommended schedules) and additional considerations used to inform public health recommendations for fully vaccinated people, including:

- Vaccine efficacy and effectiveness against SARS-CoV-2 infection in the general population as well as among immunocompromised persons
- Vaccine effectiveness of heterologous (mixed) vaccination series
- Vaccine performance (i.e., immunogenicity and effectiveness) against emerging SARS-CoV-2 variant viruses, with a particular focus on the [Delta \(B.1.617.2\) variant](#)

Current evidence indicates that fully vaccinated people without immunocompromising conditions are able to engage in most activities with low risk of acquiring or transmitting SARS-CoV-2, with additional prevention measures (e.g. masking) [where transmission is substantial or high](#).

Emerging SARS-CoV-2 viral variants

As of August 28, 2021, the Delta variant of concern (B.1.617.2) is the predominant variant in the United States, with 99% of sequenced specimens being identified as Delta; current data on variant prevalence can be found [on CDC's website](#). The Delta variant, first detected in India, has been shown to have increased transmissibility, potential reduction in neutralization by some monoclonal antibody treatments, and reduction in neutralization by post-vaccination sera.⁽²⁾

Other variants that are either no longer detected or are circulating at very low levels in the United States include: Alpha (B.1.1.7), first detected in the United Kingdom; Beta (B.1.351), first detected in South Africa; Gamma (P.1), first detected in Japan/Brazil; Iota (B.1.526), first detected in the United States-New York; Eta (B.1.525), first detected in the United Kingdom/Nigeria; Kappa (B.1.617.1) and B.1.617.3, first detected in India. These variants have mutations that alter the

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receptor binding domain of the spike protein and have variable impact on vaccine effectiveness (notably the E484K/Q mutation in Beta, Gamma, Eta, Iota, Kappa, and B.1.617.3; the N501Y mutation occurring in Alpha, Beta, and Gamma; the E417T/N mutations in Beta and Gamma; and the L452R mutation in Delta, Kappa and B.1.617.3).(2) Vaccine performance against emerging SARS-CoV-2 variants is an important consideration when evaluating the need for prevention measures in vaccinated people and will require continued monitoring.

COVID-19 vaccine efficacy, effectiveness, and immunogenicity

Immunogenicity is the generation of effective protective immunity against a vaccine antigen as measured by laboratory tests. Vaccine efficacy refers to how well a vaccine performs in a carefully controlled clinical trial, and effectiveness describes its performance in real-world observational studies. Evidence demonstrates that the approved or authorized COVID-19 vaccines are both efficacious and effective against symptomatic, laboratory-confirmed COVID-19, including severe forms of the disease. In addition, as shown below, a growing body of evidence suggests that COVID-19 vaccines also reduce asymptomatic infection and transmission. Substantial reductions in SARS-CoV-2 infections (both symptomatic and asymptomatic) will reduce overall levels of disease, and therefore, SARS-CoV-2 virus transmission in the United States. Investigations are ongoing to further assess the risk of transmission from fully vaccinated persons with SARS-CoV-2 infections to other vaccinated and unvaccinated people. Early evidence suggests infections in fully vaccinated persons caused by the Delta variant of SARS-CoV-2 may be transmissible to others; however, SARS-CoV-2 transmission between unvaccinated persons is the [primary cause of continued spread](#).

Animal challenge studies

Rhesus macaque challenge studies provided the first evidence of the potential protective effects of Pfizer-BioNTech, Moderna, and Janssen COVID-19 vaccines against SARS-CoV-2 infection, including both symptomatic and asymptomatic infection. Vaccinated macaques developed neutralizing antibodies that exceeded those in human convalescent sera and showed no or minimal signs of clinical disease after SARS-CoV-2 challenge.(3-5) In addition, COVID-19 vaccination prevented or limited viral replication in the upper and lower respiratory tracts, which may have implications for transmission of the virus among humans.(3-5)

Vaccine efficacy from human clinical trials

Clinical trials subsequently demonstrated the FDA-approved or authorized COVID-19 vaccines to be efficacious against laboratory-confirmed, symptomatic COVID-19 in adults, including severe forms of the disease, with evidence for protection against both symptomatic and asymptomatic SARS-CoV-2 infection (6-12) (**Box**). Trial data demonstrated 100% efficacy of the Pfizer-BioNTech vaccine against laboratory-confirmed, symptomatic COVID-19 in adolescents 12–15 years old; this estimate was based on small numbers of cases and prior to emergence of the Delta variant.(13)

Clinical trial data suggest that the Janssen COVID-19 vaccine may have reduced overall efficacy against disease caused by the Beta variant, compared to the other COVID-19 vaccines. Although sero-response rates were similar between U.S. clinical trial participants and those from Brazil and South Africa, vaccine efficacy against moderate to severe-critical COVID-19 after ≥ 14 days was 74% in the United States (where $\sim 96\%$ of infections were due to the ancestral strain with the D614G mutation), 66% in Brazil (where $\sim 69\%$ of infections were due to Zeta [P.2]), and 52% in South Africa (where $\sim 95\%$ of infections were due to Beta).(14) Notably, Janssen vaccine showed good efficacy against severe or critical disease (73%–82%) across all sites.

Box. Summary of vaccine efficacy estimates for approved or authorized COVID-19 vaccines

All approved or authorized COVID-19 vaccines demonstrated efficacy (range 65% to 95%) against symptomatic, laboratory-confirmed COVID-19 in adults ≥ 18 years.

- For each approved or authorized COVID-19 vaccine, efficacy was demonstrated across different populations, including elderly and younger adults, in people with and without underlying health conditions, and in people representing different races and ethnicities.
- The Pfizer-BioNTech COVID-19 vaccine also demonstrated high efficacy against symptomatic, laboratory-confirmed COVID-19 in adolescents aged 12–17 years.

All approved or authorized COVID-19 vaccines demonstrated high efficacy ($\geq 89\%$) against COVID-19 severe enough to require hospitalization.

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All approved or authorized COVID-19 vaccines demonstrated high efficacy against COVID-19-associated death.

- In the clinical trials, no participants who received a COVID-19 vaccine died from COVID-19; the Moderna and Janssen vaccine trials among adults ≥ 18 years each had COVID-19 deaths in the unvaccinated placebo arm.


Data from the clinical trials among adults ≥ 18 years old suggest COVID-19 vaccination protects against symptomatic infection and may also protect against asymptomatic infection.

- In the Moderna trial, among people who had received a first dose, the number of asymptomatic people who tested positive for SARS-CoV-2 at their second-dose appointment was approximately 67% lower among vaccines than among placebo recipients (0.1% [n=15] and 0.3% [n=39], respectively)
- Efficacy of Janssen COVID-19 vaccine against asymptomatic infection was 74% in a subset of trial participants.




No trials have compared efficacy between any of the approved or authorized vaccines in the same study population at the same time, making comparisons of efficacy difficult.

- All Phase 3 trials differed by calendar time and geography.
- Vaccines were tested in settings with different background COVID-19 incidence and circulating variants.

Vaccine effectiveness from real-world studies

Multiple studies from the United States and other countries have demonstrated that a two-dose COVID-19 mRNA vaccination series is effective against SARS-CoV-2 infection (including both symptomatic and asymptomatic infections) caused by ancestral and variant strains and sequelae including severe disease, hospitalization, and death. Early evidence for the Janssen vaccine also demonstrates effectiveness against COVID-19 in real-world conditions. There is now a substantial volume of scientific literature examining the effectiveness of COVID-19 vaccination against SARS-CoV-2 infection, symptomatic disease, and other clinical outcomes; detailed summaries of these studies are available in the International Vaccine Access Center's [VIEW-Hub resource library](#) .

Several systematic reviews and meta-analyses of vaccine effectiveness have recently been published (15-17); meta-analyses indicate an average effectiveness of full vaccination against SARS-CoV-2 infection of 85%–95% shortly after completion of vaccination. (16, 17) However, many of the studies in these reviews were conducted prior to the emergence of the variants of concern. Studies in Israel, Europe, and the United Kingdom have demonstrated high real-world effectiveness (>85%) of two doses of Pfizer-BioNTech COVID-19 vaccine while the Alpha variant was prevalent. (18-26) Studies from Qatar have demonstrated high effectiveness against documented infection with Alpha and Beta ≥ 14 days after receiving the Pfizer-BioNTech vaccine (90% and 75%, respectively) and the Moderna vaccine (100% and 96%, respectively); importantly, both vaccines were 96%–100% effective against severe, critical, or fatal disease, regardless of strain. (27, 28) In three studies from Canada, one demonstrated 79% effectiveness for mRNA vaccines against confirmed infection during a time when Alpha and Gamma represented most infections, while another two demonstrated 84% and 88% effectiveness, respectively, against symptomatic infection caused by Gamma/Beta. (29-31)

Individual studies specifically examining vaccine effectiveness against the Delta variant or conducted in the context of substantial circulation of Delta are summarized in Table 1a and as follows. Studies from the United Kingdom have noted effectiveness of the Pfizer-BioNTech vaccine against confirmed infection (79%) and symptomatic infection (88%), compared with the Alpha variant (92% and 93%, respectively). (23, 25) A study from Canada demonstrated 87% effectiveness against symptomatic illness caused by the Delta variant ≥ 7 days after receipt of the second dose of Pfizer-BioNTech vaccine, compared with 89% for the Alpha variant. (32) Data from Qatar demonstrated 54% effectiveness against symptomatic illness for the Pfizer-BioNTech vaccine compared with 85% for the Moderna vaccine. (33). [Preliminary data from South Africa](#)   on the effectiveness of the Janssen vaccine showed 71% effectiveness against hospitalization when Delta variant was predominant, compared to 67% when Beta was predominant. [Data from Israel](#)  also suggest decreased effectiveness of vaccines against infection and illness caused by Delta. The variability in vaccine effectiveness estimates between countries may in part reflect differences in study methodology, intervals used between vaccine doses, and timing of vaccine effectiveness assessments. Of note, the United Kingdom and Canada used prolonged intervals of 12–16 weeks between vaccine doses, which have been observed to induce higher immunogenicity and effectiveness (including in ages ≥ 80 years) (34-37). The most recent estimates from Israel and Qatar represent time points >6 months after initiating respective national vaccination campaigns and 2–5 months after prior assessments of vaccine effectiveness against the Alpha variant, with

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 potential for waning immunity. Notably, in the United Kingdom, Canada, Qatar, South Africa, and Israel, vaccine effectiveness against hospitalization related to Delta was >90% and comparable to that observed with Alpha for all vaccines currently approved or authorized in the United States.(26, 32, 33)

Table 1a. *Effectiveness of COVID-19 Vaccination Against SARS-CoV-2 Infection and Symptomatic Disease (Including Severe Disease and Hospitalization) Caused by the Delta Variant*

Country	Population	Vaccine	Outcome	Vaccine Effectiveness*
UK ³⁸	General population ≥ 16 years	Pfizer-BioNTech	Symptomatic disease	88% ¹ (85-90)
Canada ³²	General population ≥ 16 years	Pfizer-BioNTech	Symptomatic disease	85% ¹ (59-94)
UK (Scotland) ²⁵	General population	Pfizer-BioNTech	SARS-CoV-2 infection	79% ¹ (75-82)
UK ²³	General population	Pfizer-BioNTech	SARS-CoV-2 infection	80% ¹ (77-83)
United States ³⁹	Healthcare workers, first responders, and other essential and frontline workers	Pfizer-BioNTech, Moderna, or Janssen	SARS-CoV-2 infection	66% ¹ (26-84)
United States ⁴⁰	Health system members ≥ 12 years	Pfizer-BioNTech	SARS-CoV-2 infection	75% ² (71-78)
			Hospitalization	93% ² (84-96)
Qatar ³³	General population ≥ 12 years	Moderna	SARS-CoV-2 infection	85% ¹ (76-91)
		Pfizer-BioNTech	SARS-CoV-2 infection	54% ¹ (44-61)
		Moderna	Symptomatic disease	86% ¹ (71-94)
		Pfizer-BioNTech	Symptomatic disease	56% ¹ (41-67)
		Moderna	Severe, critical, or fatal disease	100% ¹ (41-100)
		Pfizer-BioNTech	Severe, critical, or fatal disease	90% ¹ (61-98)
UK ²⁶	Patients hospitalized following ED visit	Pfizer-BioNTech	Hospitalization	96% ¹ (86-99)

*Only studies including estimates of vaccine effectiveness ≥ 7 days following a completed vaccination series of a COVID-19 vaccine currently approved or authorized for use in the United States are included here. For studies that examined variant-specific vaccine effectiveness against multiple variants of SARS-CoV-2, only estimates for effectiveness against the Delta variant are shown. The 95% confidence interval for each estimate of vaccine effectiveness is displayed in parentheses following the estimate.

¹ ≥ 14 days after second dose

In addition to preventing morbidity and mortality associated with COVID-19, currently approved or authorized vaccines also demonstrate effectiveness against asymptomatic SARS-CoV-2 infection. However, most studies of asymptomatic infection prevention were conducted in the context of circulation of different variants and the effectiveness of COVID-19 vaccines in preventing asymptomatic infection differs by variant and vaccine. In addition, infections identified in such studies as asymptomatic may simply have been identified prior to the infected person developing symptoms, i.e., these infections are presymptomatic rather than asymptomatic. Asymptomatic people are also less likely to be tested for SARS-CoV-2 infection in most settings and thus less likely to be captured in “real world” effectiveness studies.

Table 1b. *Effectiveness of COVID-19 Vaccination Against Asymptomatic SARS-CoV-2 Infection When Different Variants Predominated*

Country	Population	Vaccine	Dominant Variant(s)	Vaccine Effectiveness*
Israel ²⁴	Healthcare workers	Pfizer-BioNTech	Alpha	65% ¹ (45-79)
United States (California) ⁴¹	General population ≥18 years	Pfizer-BioNTech or Moderna	Epsilon, Alpha	68% ² (29-86)
United States ⁴²	Preprocedural adult patients	Pfizer-BioNTech or Moderna	Ancestral strain	80% ³ (56-91)
Qatar ³³	General population ≥12 years	Moderna	Delta	80% ⁴ (54-93)
		Pfizer-BioNTech	Delta	36% ⁴ (11-54)
Israel ⁴³	Healthcare workers	Pfizer-BioNTech	Alpha	86% ⁵ (69-93)
Israel ²¹	General population ≥16 years	Pfizer-BioNTech	Alpha	92% ⁵ (91-92)
Israel ¹⁹	General population ≥16 years	Pfizer-BioNTech	Ancestral strain, Alpha	90% ⁵ (83-94)

*The 95% confidence interval for each estimate of vaccine effectiveness is displayed in parentheses following the estimate.

¹≥11 days after second dose

²≥15 days after second dose

³≥0 days after second dose


⁴≥14 days after second dose

⁵≥7 days after second dose

Vaccine immunogenicity and effectiveness in immunocompromised people

Vaccination is particularly important for people with immunocompromising conditions, who are at increased risk of severe COVID-19 illness. However, current evidence suggests reduced protection from COVID-19 vaccines for many immunocompromised persons. Recent studies in several countries found significantly lower vaccine effectiveness among immunocompromised adults compared to those without immunocompromising conditions (44-46) (Table 2), although each study defined the immunocompromised population differently. Studies in the United States and Israel have also found that immunocompromised persons account for a high proportion (≥40%) of infections among fully vaccinated hospitalized persons. (46, 47)

Compared with those who are not immunocompromised, reduced antibody response to a two-dose primary series of mRNA COVID-19 vaccines has also been observed in specific groups of immunocompromised adults, including people receiving solid organ transplants (48-54); some people with cancer, particularly hematologic cancers (55, 56); some people receiving

hemodialysis for kidney disease (57, 58); and people taking certain immunosuppressive medications (51, 53, 54, 59). While antibody measurement and threshold levels varied by study, a large proportion of immunocompromised persons overall had a measurable immune response after a two-dose series of mRNA vaccine, although some remained seronegative. The distribution of antibody response by immunocompromising condition in [several recent studies](#)  is summarized in Figure 1.

Emerging data suggest an additional COVID-19 vaccine dose in immunocompromised people, typically administered at least 28 days after completion of the primary series, increases antibody response: in small observational studies of solid organ transplant recipients (60-63) or hemodialysis patients (64-66), 33%-54% of persons who had no detectable antibody response to an initial two-dose mRNA vaccine series developed an antibody response to an additional dose of a COVID-19 vaccine. A recently published randomized controlled trial demonstrated substantial increases in serologic immune response to a third dose of Moderna's mRNA vaccine compared with placebo among solid organ transplant recipients who previously received a two-dose series of that vaccine.(67) While these studies evaluated serologic immune response to an additional vaccine dose, the clinical impact of an additional dose on acquisition, severity, and infectiousness of infections in fully vaccinated immunocompromised persons is not yet known.

Table 2. Effectiveness of COVID-19 Primary Series Vaccination Against SARS-CoV-2 Infection and Symptomatic Disease among Immunocompromised Persons

Country	Population	Vaccine	Outcome	Dominant Variant(s)	Vaccine Effectiveness in IC Population	Vaccine Effectiveness in Comparison Population*
United States ⁴⁵	Veterans ≥18 years taking immunosuppressive medications for inflammatory bowel disease	Pfizer-BioNTech or Moderna	SARS-CoV-2 infection	Unknown	69% ¹ (44-83)	No comparison
United States ⁶⁸	Solid organ transplant recipients	Pfizer-BioNTech, Moderna, or Janssen	SARS-CoV-2 infection	Ancestral strain, Alpha	81% ² (50-95)	No comparison
Israel ⁴⁴	General population ≥16 years	Pfizer-BioNTech	SARS-CoV-2 infection	Ancestral strain, Alpha	71% ¹ (37-87)	90%(79-95)
			Symptomatic disease		75% ¹ (44-88)	94%(88-97)
Qatar ⁶⁹	Kidney transplant recipients	Pfizer-BioNTech or Moderna	SARS CoV-2 infection	Alpha, Beta	47% ² (0-74)	No comparison
			Severe, critical, or fatal COVID-19 disease		72% ² (0-91)	
United States ⁴⁶	Hospitalized patients ≥18 years	Pfizer-BioNTech or Moderna	Hospitalization	Ancestral strain, Alpha	59% ² (12-81)	91%(86-95)

IC: Immunocompromised

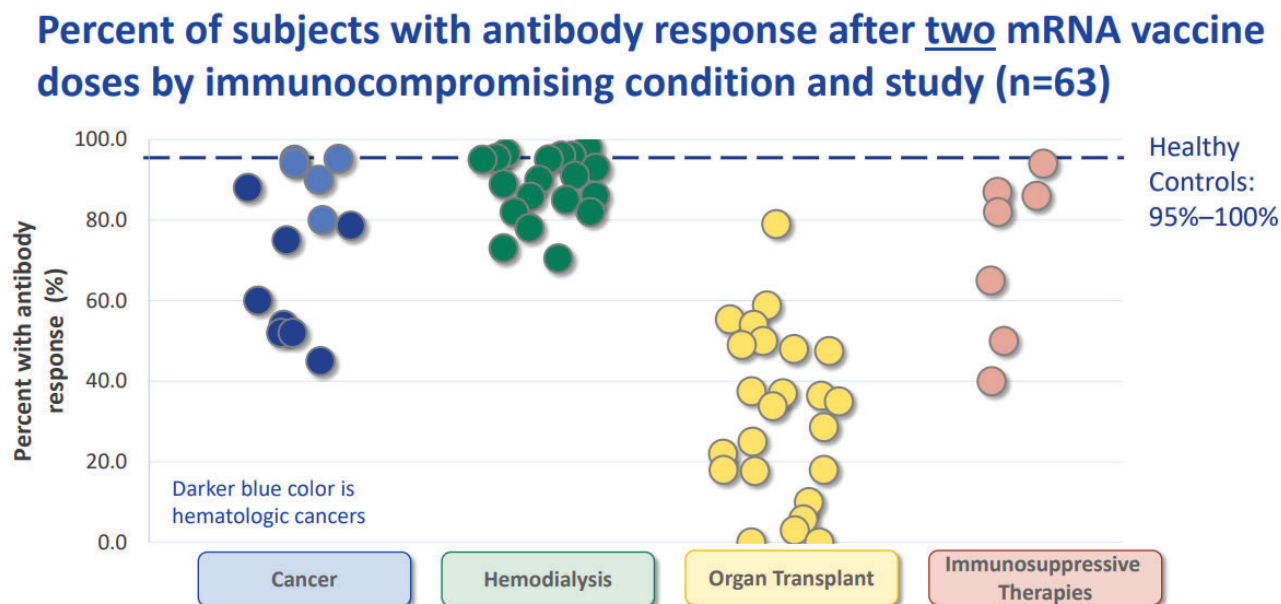
* In the Israeli study, the comparison is with overall vaccine effectiveness (i.e., vaccine effectiveness in the entire study population, including those with immunocompromising conditions). In the U.S. study, the comparison is with vaccine effectiveness among members of the study population without immunocompromising conditions.

The 95% confidence interval for each estimate of vaccine effectiveness is displayed in parentheses following the estimate.

¹≥7 days after second dose

²≥14 days after second dose

Figure 1:



*The studies displayed in Figure 1 represent the results of a literature review conducted by the Advisory Committee on Immunization Practices' COVID-19 Vaccines Work Group and are current as of July 21, 2021. Numerous additional studies of antibody response to COVID-19 vaccination in various immunocompromised populations have been published since that date and are not captured here.

Vaccine immunogenicity and effectiveness of heterologous (mixed) dosing regimens

Multiple small studies from Europe have examined the immunogenicity of a heterologous or 'mixed' series of COVID-19 vaccines. These studies found that receipt of a dose of AstraZeneca's adenovirus vector vaccine followed by a dose of an mRNA vaccine (most frequently Pfizer-BioNTech) induced a robust immune response (70-72) and was at least as immunogenic as two doses of mRNA vaccines by most measures of immune response.(73-79) One study examined vaccine effectiveness of this heterologous series and estimated an effectiveness of 88% against any SARS-CoV-2 infection two weeks following the mRNA (second) dose.(80) Only one study examined a heterologous series in which the mRNA vaccine was the priming (first) dose; this study found that a dose of Pfizer-BioNTech vaccine followed by a dose of AstraZeneca vaccine did not achieve non-inferiority of immune response when compared with two doses of Pfizer-BioNTech.(81) A single study to date examined heterologous dosing with a primary mRNA vaccine series followed by a dose of the Janssen adenovirus vector COVID-19 vaccine in four subjects and noted substantially increased immune response against SARS-CoV-2 after the third dose.(82)

Vaccine-induced neutralizing antibody activity

Sera from mRNA COVID-19 vaccine (both Pfizer-BioNTech and Moderna) recipients have demonstrated minimal to large reductions in antibody neutralization activity against a variety of mutations, as reviewed in [VIEW-Hub](#) [VIEW-Hub](#). Two related systematic reviews and meta-analyses have also been published (83, 84); however, these reviews do not include all available neutralization studies of the Delta variant with sera from people who received mRNA vaccines or the Janssen vaccine.(85-96) Across studies of VOCs, the greatest reductions were observed for Beta, followed by Gamma and Delta; reductions for Alpha were minimal. The E484K/Q and L452R mutations alone or in combination with other mutations in the receptor binding domain have been shown to account for the majority of the reduction in vaccine-induced neutralizing antibody activity for the Beta, Gamma, and Delta variants.(97-103) Alpha and Iota variants with E484K mutations, which have been detected in the United Kingdom, United States, and other countries, have shown further reductions in neutralization above Alpha and Iota alone, respectively.(87, 97, 104-109) For two-dose COVID-19 vaccines, multiple studies have shown greater neutralization against variants after the second dose (i.e. among fully vaccinated people) compared with after the first dose alone.(88, 91, 97,

Robust correlation has been demonstrated between vaccine efficacy and neutralizing antibody levels induced by different vaccines.(119, 120) Based on evidence from clinical trials, the correlate of protection, or antibody threshold providing protection against severe disease, has been estimated to be much lower than that required for protection against confirmed infection.(120) However, in the absence of an accepted antibody threshold that correlates with protection, it is difficult to fully predict how reduced neutralizing activity may affect COVID-19 vaccine effectiveness. Some variants may reduce neutralizing antibody levels to near or below the protective threshold, resulting in lowered vaccine efficacy, increased infections in vaccinated persons, and shortened duration of immunity, and others may not be significant.

Vaccine-induced cellular immunity

Several studies have assessed CD4+ and CD8+ T cell responses from Moderna or Pfizer-BioNTech vaccine recipients to the ancestral SARS-CoV-2 strain compared with the Alpha, Beta, Gamma, and Epsilon variants; these studies observed modest or no defects in cellular immune recognition of the variants.(112, 116, 121-126) Thus, cellular immunity may help limit disease severity in infections caused by variants that partially escape neutralizing antibodies. Variations in the genes encoding human leukocyte antigens have been observed to result in variation of the T cell response to specific SARS-CoV-2 variants, which may impact different subpopulations differently based on genetic prevalence of these variations.(127-132) There are currently no studies of vaccine-induced cellular immunity against the Delta variant.

Older adults and long-term care facility residents

Multiple studies have noted reduced vaccine effectiveness in older adults (≥ 60 years) (38, 133-135) or residents of long-term care facilities, compared with general population estimates.(136-138) Compared with younger individuals, persons aged >80 years have been noted to have reduced T-cell responses, lower neutralizing antibody levels, and less potential antibody diversity (somatic hypermutation), potentially giving this group increased risk for susceptibility to SARS-CoV-2 infection in vaccinated people. (139) Two studies have observed poor antibody response to the Pfizer-BioNTech vaccine among nursing home residents compared with staff (140, 141); one study noted 38% of nursing home residents had undetectable antibodies to the Beta variant at 2–4 weeks after the second dose of Pfizer-BioNTech vaccine, compared with 12% with Moderna vaccine. (140) Another study showed declining antibody levels among nursing home residents, with 72% of residents having undetectable neutralizing antibody levels at 6 months post-vaccination with Pfizer-BioNTech.(142)

Duration of protection

Immunogenicity of COVID-19 vaccines has been demonstrated out to 6–8 months after vaccination.(86, 143) At 2–3 months post vaccination, two studies have shown lower neutralizing titers, including against the Beta and Delta variants, for Janssen (an adenovirus vector vaccine) compared with the mRNA vaccines.(144, 145) Two studies have shown a combined impact of waning antibody levels and reduced neutralization of variants; six months after receiving the Moderna vaccine, neutralizing antibody levels were reduced but sufficient to protect against the ancestral strain, while about 50% of people had undetectable neutralization activity against Beta and Gamma compared with the ancestral strain.(146, 147) However, a small study of people 8 months after receiving the Janssen vaccine had minimal decline in neutralizing titers against Beta, Gamma, and Delta and there was evidence of expanded breadth of neutralizing antibody response against variants over this time period, likely through B cell maturation.(86) More evidence is still needed in this area, including understanding potential differences in the kinetics of immune response related to different vaccine platforms. One recent modeling study based on immunogenicity data predicted that vaccine effectiveness against symptomatic infection caused by the Delta variant may drop below 50% within the first year after vaccination for most current vaccines in use globally, while the majority are protected from severe illness.(148)

Six-month clinical efficacy for the Pfizer-BioNTech vaccine shows an overall efficacy against infection of 91% and 97% efficacy against severe illness.(149) However, a non-significant decrease of six percentage points was observed for every two months ≥ 7 days post-vaccination, from 96% at ≥ 7 days to <2 months, 90% at 2 to <4 months, and 84% at 4 to <6 months. Similar results for the Moderna vaccine have not yet been published, but [data from the manufacturer](#) cite 93% overall efficacy up to 6 months.

Several recent studies have noted decreases over time in the effectiveness of COVID-19 vaccines against SARS-CoV-2 infection. A study of U.S. long-term care residents, who were among the first groups in the United States to be vaccinated, found effectiveness of mRNA vaccination against infection declined from 75% in March–May 2021 to 53% in June–July 2021. (150) A study of adults in one U.S. state found a decline in vaccine effectiveness against SARS-CoV-2 infection from 92% the week of May 3, 2021 to 80% the week of July 19, 2021.(151) Two studies in large U.S. health systems examined mRNA vaccine effectiveness longitudinally from December 2020 and January 2021 through July 2021 and August 2021 and noted marked declines over this period (40, 152); similarly, a large population-based study in the UK identified decreases in effectiveness of

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Pfizer-BioNTech vaccination over 4-5 months following the second dose.(153) Observed changes in vaccine effectiveness against infection with SARS-CoV-2 may reflect reduced vaccine performance against the Delta variant, waning immunity from primary vaccination, or other unmeasured confounders. In addition, as people at the highest risk of SARS-CoV-2 infection were generally vaccinated first, observational studies of duration of immunity may be subject to confounding by risk status. Importantly, data as of July 2021 confirm sustained high effectiveness of full mRNA vaccination against COVID-19 hospitalization, even up to 6 months post-vaccination.(151, 154)

A retrospective cohort study in a large healthcare system in Israel noted a 2.3-fold increased risk for infection among fully vaccinated persons who were vaccinated with Pfizer-BioNTech in January vs. April 2021.(155) A similar study observed a higher rate (2.4% v. 1.1%, OR=2.2) of infection in fully vaccinated persons who received the second Pfizer-BioNTech dose ≥ 5 months ago compared with those who received it < 5 months ago, with higher magnitude of difference with increasing age. (156)

Infections in fully vaccinated persons: clinical implications and transmission

As expected, because no vaccine is 100% effective, infections in fully vaccinated persons (e.g. breakthrough [infections](#)) have been observed, albeit at much lower rates than infections among unvaccinated persons; vaccine effectiveness against severe disease remains high. From January through June 2021, COVID-NET data from laboratory-confirmed COVID-19-associated hospitalizations in adults ≥ 18 years of age for whom vaccination status is known showed 3% of hospitalizations occurred in fully vaccinated persons. In general, symptoms and duration of illness in infections among fully vaccinated persons have been attenuated compared with cases among unvaccinated people.(157) CDC conducts nationwide monitoring of [infections in fully vaccinated persons](#) resulting in hospitalization or death. Among hospitalized or fatal cases reported to CDC as of August 30, 2021, 70% of hospitalized cases and 87% of fatal cases of COVID-19 in fully vaccinated persons were in persons aged 65 years or older. Infections in fully vaccinated persons may be associated with lower antibody levels compared with those who maintain protection, as shown in a study of fully vaccinated healthcare workers in Israel with infections caused by the Delta variant.(158) However, infection in a fully vaccinated person may boost immunity; four weeks after an outbreak in a long-term care facility, fully vaccinated residents who experienced SARS-CoV-2 infections were found to have significantly higher antibody levels than vaccinated individuals who did not experience SARS-CoV-2 infections.(159)

The proportions of VOCs observed among cases in fully vaccinated persons has been similar to that observed in [CDC's national genomic surveillance](#).(160) but interpretation of these data are challenging because of local variation and changes in variant proportions over time. An Israeli study of VOC infections in adults fully vaccinated with Pfizer-BioNTech vaccine compared with unvaccinated matched controls, during a time when Alpha was the dominant strain and Beta was detected in $< 1\%$ of all specimens, found a higher proportion of Beta in fully vaccinated cases (matched odds ratio = 8.0) and a higher proportion of Alpha in partially vaccinated cases (matched odds ratio = 2.6), though small sample sizes, especially for Beta, were noted as a limitation.(161) Results of a study from Maryland showed that variants with E484K substitutions (e.g., Beta, Gamma) were associated with increased odds of SARS-CoV-2 infection (OR=2.0) in fully vaccinated persons and infection in fully vaccinated persons associated with hospitalization (OR=2.6), while L452R substitutions (e.g., Delta) were not.(162) However, a study from Houston, Texas observed that Delta caused a significantly higher rate of infections in fully vaccinated people compared with infections from other variants, but noted that only 6.5% of all COVID-19 cases occurred in fully vaccinated individuals(163); similar findings were noted in India.(96)

In studies conducted before the emergence of the Delta variant, data from multiple studies in different countries suggested that people vaccinated with mRNA COVID-19 vaccines who develop COVID-19 generally have a lower viral load than unvaccinated people.(157, 165-169) This observation may indicate reduced transmissibility, as viral load has been identified as a key driver of transmission.(170) Studies from multiple countries found significantly reduced likelihood of transmission to household contacts from people infected with SARS-CoV-2 who were previously vaccinated for COVID-19.(171-176) For the Delta variant, early data indicate vaccinated and unvaccinated persons infected with Delta have similar levels of viral RNA and culturable virus detected, indicating that some vaccinated people infected with the Delta variant of SARS-CoV-2 may be able to transmit the virus to others.(163, 164, 177-180) However, other studies have shown a more rapid decline in viral RNA and culturable virus in fully vaccinated people (96, 177, 180-182). One study observed that Delta infection in fully vaccinated persons was associated with significantly less transmission to contacts than persons who were unvaccinated or partially vaccinated.(181)

Together, these studies suggest that vaccinated people who become infected with Delta have potential to be less infectious than infected unvaccinated people. However, more data are needed to understand how viral shedding and transmission from fully vaccinated persons are affected by SARS-CoV-2 variants, time since vaccination, and other factors, particularly as

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transmission dynamics may vary based on the extent of exposure to the infected vaccinated person and the setting in which the exposure occurs. Additional data collection and studies are underway to understand the extent and duration of transmissibility of Delta variant SARS-CoV-2 in the United States and other countries.

Conclusions

COVID-19 vaccines currently approved or authorized in the United States have been shown to provide considerable protection against severe disease and death caused by COVID-19. These findings, along with the early evidence for reduced levels of viral mRNA and culturable virus in vaccinated people who acquire SARS-CoV-2 infection, suggest that any associated transmission risk is substantially reduced in vaccinated people: even for Delta, evidence suggests fully vaccinated people who become infected are infectious for shorter periods of time than unvaccinated people infected with Delta. While vaccine effectiveness against emerging and other SARS-CoV-2 variants will continue to be assessed, available evidence suggests that the COVID-19 vaccines approved or authorized in the United States offer substantial protection against hospitalization and death from emerging variants, including the Delta variant. Data suggest lower vaccine effectiveness against laboratory-confirmed illness and symptomatic disease caused by the Beta, Gamma, and Delta variants compared with the ancestral strain and Alpha variant. Early data also find some decline in vaccine effectiveness against SARS-CoV-2 infection over time, although in fall 2021, 9 months after the start of the U.S. COVID-19 vaccination program, vaccination remains highly protective against hospitalization with COVID-19.

Evidence suggests the U.S. COVID-19 vaccination program has substantially reduced the burden of disease in the United States by preventing serious illness in fully vaccinated people and interrupting chains of transmission. Vaccinated people can still become infected and have the potential to spread the virus to others, although at much lower rates than unvaccinated people. The risks of SARS-CoV-2 infection in fully vaccinated people are higher where community transmission of the virus is widespread. Current efforts to maximize the proportion of the U.S. population that is fully vaccinated against COVID-19 remain critical to ending the COVID-19 pandemic.

*Note: This brief summarizes evidence related to vaccines approved or authorized for emergency use in the United States. In [specific circumstances](#), CDC guidance for fully vaccinated people can also be applied to COVID-19 vaccines that have been listed for emergency use by the World Health Organization (e.g. AstraZeneca/Oxford) and to some vaccines used for U.S. participants in COVID-19 vaccine trials.

Previous Updates

Updates from Previous Content

As of July 27, 2021

- Data were added from studies published since the last update that demonstrate currently authorized mRNA vaccines provide protection against variants of concern, including the Delta strain that is now predominant in the United States. Vaccine effectiveness against hospitalization and death is high for all current SARS-CoV-2 variants; emerging data suggest lower effectiveness against confirmed infection and symptomatic disease caused by the Beta, Gamma, and Delta variants compared with the ancestral strain and the Alpha variant.

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Note: Preprints have not been peer-reviewed. They should not be regarded as conclusive, guide clinical practice/health-related behavior, or be reported in news media as established information.

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Previous Updates

As of May 27, 2021

- Data were added from studies published since the last update that further demonstrate currently authorized COVID-19 vaccines are effective against SARS-CoV-2 infection, symptomatic and severe disease, and hospitalization with COVID-19.
- Data were added suggesting that currently authorized mRNA vaccines provide protection against variants of concern, including the B.1.1.7 strain that is predominant in the United States.
- Data were added from studies published since the last update that further demonstrate people who are fully vaccinated with a currently authorized mRNA vaccine are protected against asymptomatic infection and, if infected, have a lower viral load than unvaccinated people.

Last Updated Sept. 15, 2021



COVID-19

Science Brief: Evidence Used to Update the List of Underlying Medical Conditions Associated with Higher Risk for Severe COVID-19

Updated Oct. 14, 2021

[Print](#)

For more information, please see [Underlying Medical Conditions Associated with Higher Risk for Severe COVID-19: Information for Healthcare Providers](#) and the [People with Certain Medical Conditions](#) webpage, which is intended for the general public.

Summary of Recent Changes

Updates as of October 14, 2021



Updates to the list of underlying medical conditions that put adults of any age at higher risk for severe illness from the virus that causes COVID-19 were based on evidence from published reports, scientific articles in press, unreviewed pre-prints, and internal data. Updates to the following conditions were completed based on evidence from the date range below:

- Chronic lung disease (including bronchiectasis, bronchopulmonary dysplasia, interstitial lung disease, pulmonary hypertension, pulmonary embolism, tuberculosis) and chronic liver disease (including cirrhosis, non-alcoholic fatty liver disease, alcoholic liver disease, and autoimmune hepatitis) were added September 2021 based on evidence published between December 1, 2019 and August 31, 2021 using the updated review methods outlined below.
- Mental health disorders (such as mood disorders including depression, and schizophrenia spectrum disorders) were added September 2021 based on evidence published between December 1, 2019 and August 31, 2021.
- No conditions were removed from the previous underlying medical conditions list.

[View Previous Updates](#)

Context

Based on available literature and data from CDC-led investigations, we continue to learn more about COVID-19 and associated underlying medical conditions that put adults at higher risk of severe illness. Severe illness from COVID-19 is defined here as hospitalization, admission to the intensive care unit (ICU), intubation or mechanical ventilation, or death. Evidence used to inform this list was determined by CDC reviewers based on available evidence about COVID-19 at time of review.

The methods used to assess underlying medical conditions have changed during the pandemic as the amount of literature and types of studies grow. For instance, preliminary versions of this list focused on providing the latest information based on descriptive data. As the literature grew, CDC investigators categorized the literature by study design. Since May 2021, the

Overview

Conditions on this list have been shown to be associated with severe illness from COVID-19. This **list might change** and, upon review as the science evolves, CDC might update it.

Since May 2021, CDC conducted systematic reviews on certain underlying medical conditions and those conditions previously categorized as having mixed evidence. These reviews are ongoing. As we complete a review, we will update the list. These underlying medical conditions are based on published reports, scientific articles in press, unreviewed pre-prints, and data from CDC-led investigations. Conditions were categorized by the type of study design in order of scientific rigor:

- **Supported by meta-analysis/systematic review:** Defined as having a significant association in at least one meta-analysis or systematic review, including reviews completed at CDC.
- **Supported by mostly cohort, case-control, or cross-sectional studies:** Defined as having a statistically significant association in at least one observational study (i.e., cohort, case-control or cross-sectional studies); may include systematic review or meta-analysis that represents one condition in a larger group of conditions (for example, kidney transplant under the category of solid organ or blood stem cell transplantation).
- **Supported by mostly case series, case reports or, if other study design, the sample size is small (and no systematic review or meta-analysis were available to review):** Defined as having a statistically significant association in one or more case series studies. If there are cohort or case-control studies, sample sizes were small. Conditions included may be rare.
- **Supported by mixed evidence:** Defined as having a statistically significant association in at least one meta-analysis or systematic review and additional studies or reviews that reached different conclusions about risk associated with a condition.

Table of Evidence

Evidence used to inform the list of underlying medical conditions that increase a person's risk of severe illness from COVID-19. In alphabetic order by section.

Tier	Condition	Evidence of Impact on COVID-19 Severity [Reference number]
Supported by meta-analysis/systematic review	Bronchiectasis	Select reference from systematic review [1, 2]
	Bronchopulmonary dysplasia	Select reference from systematic review [3]
	Pulmonary hypertension and pulmonary embolism	Select reference from systematic review [4, 5]
	Cancer	Systematic Review [6, 7] Cohort Study [8-10] Case Series [11-13] Case Control Study [14]
	Cerebrovascular disease	Meta-Analysis [15-18] Synthesis of Evidence [19] Cohort Study [20-22]
	Chronic kidney disease	Meta-Analysis [18, 23] Cohort Studies [21, 24-45], {46}* Case Series [47-49]
	Chronic liver disease (cirrhosis, non-alcoholic fatty liver disease, alcoholic liver disease, autoimmune hepatitis)	Meta-Analysis [50-54] Cohort [24, 33, 47, 55-69] Case-Control [70-75] Cross sectional [76] Case Series [77-79]
	COPD	Meta-Analysis [80-82] Systematic Review [83, 84]
	Diabetes mellitus, type 1	Meta-Analysis [85] Case Series [48] Cohort Study [20, 86-91]

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Evidence of Impact on COVID-19 Severity

Tier	Condition	[Reference number]
	Diabetes mellitus, type 2	Meta-Analysis [92] Systematic Review {93}* Gestational Diabetes Systematic Review {94}* Case Series [48] Longitudinal Study [95] Cohort Study [85, 89, 95-100]
	Heart conditions (such as heart failure, coronary artery disease, or cardiomyopathies)	Meta-Analysis [101-103] Cohort Study [20, 21]
	Interstitial lung disease	Select reference from systematic review [1, 4, 5, 104]
	Smoking, current and former	Meta-Analyses [80, 102, 105-112]
	Tuberculosis	Select reference from systematic review [113-115]
	Obesity	Meta-Analysis [116-118] Systematic Review {93}* Cohort [29, 119-127], {46, 128-131}*
	Pregnancy and Recent Pregnancy	Systematic Review [93, 132] Case Control [133, 134] Case Series [135-137] Cohort Study [138-141]
	Mental health disorders (mood disorders, including depression, and schizophrenia spectrum disorders)	Meta-analysis [142, 143]
Supported by mostly cohort, case-control, or cross-sectional studies (if there is a systematic review or meta-analysis available, it represents one condition in a larger category of conditions)	Children with certain underlying conditions	Systematic Review [144, 145] Cross-Sectional Study [146-148] Cohort Study [149-157] Case Series [158, 159]
	Down syndrome	Cohort Study [160, 161]
	HIV	Cohort Study [37, 162-164] Case Series [165-167]
	Neurologic conditions	Review [168] Cross-Sectional Study [146] Cohort Study [21, 149]
	Overweight	Cohort Study [122] Case Series [127]
	Sickle cell disease	Cohort [158, 159, 169, 170] Case Series [158, 170-185]
	Solid organ or blood stem cell transplantation	Meta-Analysis [125] Case Series [186-197] Cohort [198]
	Substance use disorders	Case-Control Study [199-201] Cohort Study [202, 203]
	Use of corticosteroids or other immunosuppressive medications	Cohort Study [204] Cross Sectional [205] Case Series [206-208]
Supported by mostly case series, case reports or, if other study design, the sample size is small (and no systematic review or meta-analysis available were reviewed)	Cystic fibrosis	Case Series [209-211] Cohort [212]
	Thalassemia	Case Series [213-216] Cross Sectional [217]
Supported by mixed evidence	Asthma	Meta-Analysis [218-220] Review [221] Case Series [222] Cohort Study [21, 45, 223-228]
	Hypertension, possibly	Meta-Analysis [102, 229-232] Systematic Review [233], {93}* Cohort Study [20, 21, 24, 225, 234-240] Case Series [241]

Tier	Condition	Evidence for Impact on COVID-19 Severity [Reference number]
	Immune deficiencies	Meta-Analysis [242] Cohort [243-245] Case Series [186, 187, 195, 246-249]

Footnote: { }* indicates pregnancy-related reference.

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Previous Updates

Updates from Previous Content



As of May 13, 2021

- Pregnancy related references were added in May 2021.
- Substance use disorders were based on evidence published between December 1, 2019 and January 1, 2021.
- Asthma, blood disorders, cancer, cerebrovascular disease, chronic obstructive pulmonary disease (COPD), chronic kidney disease (CKD), cystic fibrosis, diabetes, Down syndrome, heart disease, hypertension, immunosuppressant medications, use of corticosteroids or other immunosuppressive medications, solid organ or blood stem cell transplantation, neurological conditions, and obesity were based on evidence published between December 1, 2019 and December 1, 2020.
- Smoking was based on evidence published between December 1, 2019 and July 20, 2020.

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U.S. Equal Employment Opportunity Commission

Section 12: Religious Discrimination

This guidance document was issued upon approval by vote of the U.S. Equal Employment Opportunity Commission.

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Concise Display Name:

Section 12: Religious Discrimination

Issue Date:

01-15-2021

General Topics:

Religion

Summary:

This document addresses Title VII's prohibition against religious discrimination in employment, including topics such as religious harassment, and workplace accommodation of religious beliefs and practices.

Citation:

Title VII

Document Applicant:

Employers, Employees, Applicants, Attorneys and Practitioners, EEOC Staff

Previous Revision:

Yes. This document replaces previously existing guidance by the same title issued 7/22/08.

The contents of this document do not have the force and effect of law and are not meant to bind the public in any way. This document is intended only to provide clarity to the public regarding existing requirements under the law or agency policies.

		Number
<i>EEOC</i>	<i>DIRECTIVES TRANSMITTAL</i>	915.063
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SUBJECT:	Compliance Manual on Religious Discrimination
PURPOSE:	This sub-regulatory document supersedes the Commission’s Compliance Manual on Religious Discrimination issued on July 22, 2008. The contents of this document do not have the force and effect of law and are not meant to bind the public in any way. Any final document is intended only to provide clarity to the public regarding existing requirements under the law or agency policies.
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Janet Dhillon, Chair

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This Section of the Compliance Manual focuses on religious discrimination under Title VII

of the Civil Rights Act of 1964 (Title VII). Title VII protects workers from employment discrimination based on their race, color, religion, sex (including pregnancy, sexual orientation, and transgender status),[2] national origin, or protected activity. Under Title VII, an employer is prohibited from discriminating because of religion in hiring, promotion, discharge, compensation, or other “terms, conditions or privileges” of

employment, and also cannot “limit, segregate, or classify” applicants or employees based on religion “in any way which would deprive or tend to deprive any individual of employment opportunities or otherwise adversely affect his status as an employee.”[3] The statute defines “religion” as including “all aspects of religious observance and practice, as well as belief, unless an employer demonstrates that [it] is unable to reasonably accommodate . . . without undue hardship on the conduct of the employer’s business.”[4] “Undue hardship” under Title VII is not defined in the statute but has been defined by the Supreme Court as “more than a de minimis cost”[5] – a lower standard for employers to satisfy than the “undue hardship” defense under the Americans with Disabilities Act (ADA), which is defined by statute as “significant difficulty or expense.”[6]

These protections apply whether the religious beliefs or practices in question are common or non-traditional, and regardless of whether they are recognized by any organized religion.[7] The test under Title VII’s definition of religion is whether the beliefs are, in the individual’s “own scheme of things, religious.”[8] Belief in God or gods is not necessary; nontheistic beliefs can also be religious for purposes of the Title VII exemption as long as they “occupy in the life of that individual “a place parallel to that filled by . . . God” in traditionally religious persons.”[9] The non-discrimination provisions of the statute also protect employees who do not possess religious beliefs or engage in religious practices.[10] EEOC, as a federal government enforcement agency, and its staff, like all governmental entities, carries out its mission neutrally and without any hostility to any religion or related observances, practices, and beliefs, or lack thereof.[11]

The number of religious discrimination charges filed with EEOC has increased significantly from fiscal years 1997 to 2019, although the total number of such charges remains relatively small compared to charges filed on other bases.[12] Many employers seek legal guidance in managing equal employment opportunity (“EEO”) issues that arise from religious diversity as well as the demands of the modern American workplace. This document is designed to be a practical resource for employers, employees, practitioners, and EEOC enforcement staff on Title VII’s prohibition against religious discrimination. It explains the variety of issues considered in workplace-related religious discrimination claims, discusses typical scenarios that may arise, and provides guidance to employers on how to balance the rights of individuals in an environment that includes people of varying religious faiths, or no faith.[13] **However, this document does not have the force and effect of law and is not meant to bind the public in any way. It is intended to**

provide clarity to the public on existing requirements under the law and how the Commission will analyze these matters in performing its duties.

For ease of reference this document is organized by the following topics:

I – Coverage issues, including the types of cases that arise, the definition of “religion” and “sincerely held,” the religious organization exemption, and the ministerial exception.

II – Employment decisions based on religion, including recruitment, hiring, segregation, promotion, discipline, and compensation, as well as differential treatment with respect to religious expression; customer preference; security requirements; and bona fide occupational qualifications.

III – Harassment, including harassment based on religious belief or practice as a condition of employment or advancement, hostile work environment, and employer liability issues.

IV – Reasonable accommodation, including notice of the conflict between religion and work where applicable, scope of the accommodation requirement and “undue hardship” defense, and common methods of accommodation.

V – Related forms of discrimination, such as discrimination based on national origin, race, or color, as well as retaliation.

12-I COVERAGE

Types of Cases

Title VII prohibits covered employers, employment agencies, and unions^[14] from engaging in disparate treatment and from maintaining policies or practices that result in unjustified disparate impact based on religion. Historically, courts and the Commission characterized denial of accommodation as a separate cause of action. ^[15] In *EEOC v. Abercrombie & Fitch Stores, Inc.*, the Supreme Court stated that there are only two causes of action under Title VII: “disparate treatment” (or “intentional discrimination”) and “disparate impact.”^[16] It treated a claim based on a failure to accommodate a religious belief, observance, or practice (absent undue hardship) as a form of disparate treatment.^[17] The Commission recognizes that harassment and denial of religious accommodation are typically forms of disparate treatment in the terms and conditions of employment. Different types of fact patterns may arise in relation to Title VII religious discrimination, including:

- treating applicants or employees differently (disparate treatment) by taking an adverse action based on their religious beliefs, observances, or practices (or lack of religious beliefs, observances or practices) in any aspect of employment, including recruitment, hiring, assignments, discipline, promotion, discharge, and benefits;
- taking adverse action motivated by a desire to avoid accommodating a religious belief, observance, or practice that the employer knew or suspected may be needed and would not pose an undue hardship;
- denying a needed reasonable accommodation sought for an applicant's or employee's sincerely held religious beliefs, observances, or practices if an accommodation will not impose an undue hardship on the conduct of the business;
- intentionally limiting, segregating or classifying employees based on the presence or absence of religious beliefs, observances, or practices (also a form of disparate treatment), or enforcing a neutral rule that has the effect of limiting, segregating, or classifying an applicant or employee based on religious beliefs, observances, or practices and that cannot be justified by business necessity (disparate impact);
- subjecting employees to harassment because of their religious beliefs, observances, or practices (or lack of religious beliefs, observances or practices) or because of a belief that someone of the employee's religion should not associate with someone else (e.g., discrimination because of an employee's religious inter-marriage, etc.);
- retaliating against an applicant or employee who has opposed discrimination on the basis of religion, or participated in any manner in an investigation, proceeding, or hearing regarding discrimination on the basis of religion, including by filing an equal employment opportunity (EEO) charge or testifying as a witness in someone else's EEO matter, or complaining to a human resources department about alleged religious discrimination.

Although more than one of these issues may be raised in a particular case, they are discussed in separate parts of this manual for ease of use.

• NOTE TO EEOC INVESTIGATORS •

Charges involving religion, like charges filed on other bases, may give rise to more than one theory of discrimination (e.g., termination, harassment, denial of reasonable accommodation, or other forms of disparate treatment, as well as retaliation). Therefore, these charges could be investigated and analyzed under all theories of liability to the extent applicable.

A. Definitions

Overview: Religion is very broadly defined for purposes of Title VII. The presence of a deity or deities is not necessary for a religion to receive protection under Title VII. Religious beliefs can include unique beliefs held by a few or even one individual; however, mere personal preferences are not religious beliefs. Individuals who do not practice any religion are also protected from discrimination on the basis of religion or lack thereof. Title VII requires employers to accommodate religious beliefs, practices and observances if the beliefs are “sincerely held” and the reasonable accommodation poses no undue hardship on the employer.

1. Religion

Title VII defines “religion” to include “all aspects of religious observance and practice as well as belief,” not just practices that are mandated or prohibited by a tenet of the individual’s faith.^[18] Religion includes not only traditional, organized religions such as Christianity, Judaism, Islam, Hinduism, Sikhism, and Buddhism, but also religious beliefs that are new, uncommon, not part of a formal church or sect, only subscribed to by a small number of people, or that seem illogical or unreasonable to others.^[19] Further, a person’s religious beliefs “need not be confined in either source or content to traditional or parochial concepts of religion.”^[20] A belief is “religious” for Title VII purposes if it is “religious” in the person’s “own scheme of things,” i.e., it is a “sincere and meaningful” belief that “occupies a place in the life of its possessor parallel to that filled by . . . God.”^[21] The Supreme Court has made it clear that it is not a court’s role to determine the reasonableness of an individual’s religious beliefs, and that “religious beliefs need

Religious beliefs include theistic beliefs as well as non-theistic “moral or ethical beliefs as to what is right and wrong which are sincerely held with the strength of traditional religious views.”^[24] Although courts generally resolve doubts about particular beliefs in favor of finding that they are religious,^[25] beliefs are not protected merely because they are strongly held. Rather, religion typically concerns “ultimate ideas” about “life, purpose, and death.”^[26]

Courts have looked for certain features to determine if an individual's beliefs can be considered religious. As one court explained: "First, a religion addresses fundamental and ultimate questions having to do with deep and imponderable matters. Second, a religion is comprehensive in nature; it consists of a belief-system as opposed to an isolated teaching. Third, a religion often can be recognized by the presence of certain formal and external signs."^[27]

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observe certain dietary restrictions for religious reasons while another employee adheres to the very same dietary restrictions but for secular (e.g., health or environmental) reasons.^[32] In that instance, the same practice in one case might be subject to reasonable accommodation under Title VII because an employee engages in the practice for religious reasons, and in another case might not be subject to reasonable accommodation because the practice is engaged in for secular reasons.^[33] However, EEOC and courts must exercise a “light touch” in making this determination.^[34]

The following examples illustrate these concepts:

EXAMPLE 1

Employment Decisions Based on “Religion”

An otherwise qualified applicant is not hired because he is a self-described evangelical Christian. A qualified non-Jewish employee is denied promotion because the supervisor wishes to give a preference based on religion to a fellow Jewish employee. An employer terminates an employee based on his disclosure to the employer that he has recently converted to the Baha’i Faith. Each of these is an example of an employment decision based on the religious belief or practice of the applicant or employee, and therefore is discrimination based on “religion” within the meaning of Title VII.

EXAMPLE 2

Religious Practice versus Secular Practice

A Seventh-day Adventist employee follows a vegetarian diet because she believes it is religiously prescribed by scripture. Her vegetarianism is a religious practice, even though not all Seventh-day Adventists share this belief or follow this practice, and even though many individuals adhere to a vegetarian diet for purely secular reasons.

EXAMPLE 3**Types of Religious Practice or Observance**

A Catholic employee requests a schedule change so that he can attend a church service on Good Friday. A Muslim employee requests an exception to the company's dress and grooming code allowing her to wear her headscarf, or a Hindu employee requests an exception allowing her to wear her bindi (religious forehead marking). An employee asks to be excused from the religious invocation offered at the beginning of staff meetings because he objects on religious grounds or does not ascribe to the religious sentiments expressed. An adherent to Native American spiritual beliefs seeks unpaid leave to attend a ritual ceremony. An employee who identifies as Christian but is not affiliated with a particular sect or denomination requests accommodation of his religious belief that working on his Sabbath is prohibited. Each of these requests relates to a "religious" belief, observance, or practice within the meaning of Title VII. The question of whether the employer is required to grant these requests is discussed in the section below addressing religious accommodation.

EXAMPLE 4**Supervisor Considers Belief Illogical**

Morgan asks for time off on October 31 to attend the "Samhain Sabbat," the New Year observance of Wicca, her religion. Her supervisor refuses, saying that Wicca is not a "real" religion but an "illogical conglomeration" of "various aspects of the occult, such as faith healing, self-hypnosis, tarot card reading, and spell casting, which are not religious practices." The supervisor's refusal to accommodate her on the ground that he believes her religion is illogical or not a "real religion" violates Title VII unless the employer can show her request would impose an undue hardship. The law applies to religious beliefs even though others may find them "incorrect" or "incomprehensible."**[35]**

EXAMPLE 5**Unique Belief Can Be Religious**

Edward practices the Kemetic religion, based on ancient Egyptian faith, and affiliates himself with a tribe numbering fewer than ten members. He states that he believes in various deities, and follows the faith's concept of Ma'at, a guiding principle regarding truth and order that represents physical and moral balance in the universe. During a religious ceremony he received small tattoos encircling his wrist, written in the Coptic language, which express his servitude to Ra, the Egyptian god of the sun. When his employer asks him to cover the tattoos, he explains that it is a sin to cover them intentionally because doing so would signify a rejection of Ra. These can be religious beliefs and practices even if no one else or few other people subscribe to them.[36]

EXAMPLE 6**Personal Preference That Is Not a Religious Belief**

Sylvia's job has instituted a policy that employees cannot have visible tattoos while working. Sylvia refuses to cover a tattoo on her arm that is the logo of her favorite band. When her manager asks her to cover the tattoo, she states that she cannot and that she feels so passionately about the importance of the band to her life that it is essentially her religion. However, the evidence demonstrates that her tattoos and her feelings do not relate to any "ultimate concerns" such as life, purpose, death, humanity's place in the universe, or right and wrong, and they are not part of a moral or ethical belief system. Simply feeling passionately about something is not enough to give it the status of a religion in someone's life. Therefore, her belief is a personal preference that is not religious in nature.[37]

2. Sincerely Held

Title VII requires employers to accommodate those religious beliefs that are "sincerely held." [38] Whether or not a religious belief is sincerely held by an

applicant or employee is rarely at issue in many types of Title VII religious claims.

[39] For example, with respect to an allegation of discriminatory discharge or harassment, it is the motivation of the discriminating official, not the actual beliefs of the individual alleging discrimination, that is relevant in determining if the discrimination that occurred was because of religion. A detailed discussion of reasonable accommodation of sincerely held religious beliefs appears in § 12-IV, but the meaning of “sincerely held” is addressed here.

Like the religious nature of a belief, observance, or practice, the sincerity of an employee’s stated religious belief is usually not in dispute and is “generally presumed or easily established.”**[40]** Further, the Commission and courts “are not and should not be in the business of deciding whether a person holds religious beliefs for the ‘proper’ reasons. We thus restrict our inquiry to whether or not the religious belief system is sincerely held; we do not review the motives or reasons for holding the belief in the first place.”**[41]** The individual’s sincerity in espousing a religious observance or practice is “largely a matter of individual credibility.”**[42]** Moreover, “a sincere religious believer doesn’t forfeit his religious rights merely because he is not scrupulous in his observance,”**[43]** although “[e]vidence tending to show that an employee acted in a manner inconsistent with his professed religious belief is, of course, relevant to the factfinder’s evaluation of sincerity.”**[44]** Factors that – either alone or in combination – might undermine an employee’s credibility include: whether the employee has behaved in a manner markedly inconsistent with the professed belief;**[45]** whether the accommodation sought is a particularly desirable benefit that is likely to be sought for secular reasons;**[46]** whether the timing of the request renders it suspect (e.g., it follows an earlier request by the employee for the same benefit for secular reasons);**[47]** and whether the employer otherwise has reason to believe the accommodation is not sought for religious reasons.

However, none of these factors is dispositive. For example, although prior inconsistent conduct is relevant to the question of sincerity, an individual’s beliefs – or degree of adherence – may change over time, and therefore an employee’s newly adopted or inconsistently observed religious practice may nevertheless be sincerely held.**[48]** Similarly, an individual’s belief may be to adhere to a religious custom only at certain times, even though others may always adhere,**[49]** or, fearful of discrimination, he or she may have forgone his or her sincerely held religious practice during the application process and not revealed it to the employer until after he or she was hired or later in employment.**[50]** An employer also should not assume that an employee is insincere simply because some of his or her practices

deviate from the commonly followed tenets of his or her religion, or because the employee adheres to some common practices but not others.^[51] As noted, courts have held that “Title VII protects more than . . . practices specifically mandated by an employee’s religion.”^[52]

3. Employer Inquiries into Religious Nature or Sincerity of Belief

Because the definition of religion is broad and protects beliefs, observances, and practices with which the employer may be unfamiliar, the employer should ordinarily assume that an employee’s request for religious accommodation is based on a sincerely held religious belief. If, however, an employee requests religious accommodation, and an employer has an objective basis for questioning either the religious nature or the sincerity of a particular belief, observance, or practice, the employer would be justified in seeking additional supporting information. *See infra* § 12-IV-A-2.

• NOTE TO EEOC INVESTIGATORS •

If the Respondent (R) disputes that the Charging Party’s (“CP’s”) belief is “religious,” consider the following:

- ⇒ **Begin with the CP’s statements.** What religious belief, observance, or practice does the CP claim to have that conflicts with an employment requirement? In most cases, the CP’s credible testimony regarding his belief, observance, or practice will be sufficient to demonstrate that it is religious. In other cases, however, the investigator may need to ask follow-up questions about the nature and tenets of the asserted religious beliefs, and/or any associated practices, rituals, clergy, observances, etc., in order to identify a specific religious belief, observance, or practice or determine if one is at issue, which conflicts with an employment requirement.
- ⇒ **Since religious beliefs can be unique to an individual, evidence from others is not always necessary.** However, if the CP believes such evidence will support his or her claim, the investigator could seek evidence such as oral statements, affidavits, or other documents from CP’s religious leader(s) if

applicable, or others whom CP identifies as knowledgeable regarding the religious belief, observance, or practice in question that conflicts with an employment requirement.

⇒ **Remember, where an alleged religious observance, practice, or belief is at issue, a case-by-case analysis is required.**

Investigators should not make assumptions about the nature of an observance, practice, or belief. In determining whether CP's asserted observance, practice, or belief is "religious" as defined under Title VII, the investigator's general knowledge will often be sufficient; if additional objective information has to be obtained, the investigator should nevertheless recognize the intensely personal characteristics of adherence to a religious belief.

⇒ **If the Respondent disputes that CP's belief is "sincerely held," the following evidence may be relevant:**

- ⇒ Oral statements, an affidavit, or other documents from CP describing his or her beliefs and practices, including information regarding when CP embraced the belief, observance, or practice, as well as when, where, and how CP has adhered to the belief, observance, or practice; and/or,
- ⇒ Oral statements, affidavits, or other documents from potential witnesses identified by CP or R as having knowledge of whether CP adheres or does not adhere to the belief, observance, or practice at issue (e.g., CP's religious leader (if applicable), fellow adherents (if applicable), family, friends, neighbors, managers, or coworkers who may have observed his past adherence or lack thereof, or discussed it with him).

B. Covered Entities

Overview: Title VII coverage rules apply to all religious discrimination claims under the statute. However, specially defined "religious organizations" and "religious educational institutions" are exempt from certain religious discrimination provisions, and the ministerial exception bars EEO claims by employees of religious institutions who perform vital religious duties at the core of the mission of the religious institution.

Title VII's prohibitions apply to employers, employment agencies, and unions,[53] subject to the statute's coverage.[54] Those covered entities must carry out their activities in a nondiscriminatory manner and provide reasonable accommodation unless doing so would impose an undue hardship.[55] Unions also can be liable if they knowingly acquiesce in employment discrimination against their members, join or tolerate employers' discriminatory practices, or discriminatorily refuse to represent employees' interests, and employment agencies can be liable for participating in the client-employer's discrimination.[56]

C. Exceptions

1. Religious Organizations

What Entities are "Religious Organizations"? Under sections 702(a) and 703(e)(2) of Title VII, "a religious corporation, association, educational institution, or society," including a religious "school, college, university, or educational institution or institution of learning," is permitted to hire and employ individuals "of a particular religion . . ."[57] This "religious organization" exemption applies only to those organizations whose "purpose and character are primarily religious," but to determine whether this statutory exemption applies, courts have looked at "all the facts," considering and weighing "the religious and secular characteristics" of the entity.[58] Courts have articulated different factors to determine whether an entity is a religious organization, including (1) whether the entity operates for a profit; (2) whether it produces a secular product; (3) whether the entity's articles of incorporation or other pertinent documents state a religious purpose; (4) whether it is owned, affiliated with or financially supported by a formally religious entity such as a church or synagogue; (5) whether a formally religious entity participates in the management, for instance by having representatives on the board of trustees; (6) whether the entity holds itself out to the public as secular or sectarian; (7) whether the entity regularly includes prayer or other forms of worship in its activities; (8) whether it includes religious instruction in its curriculum, to the extent it is an educational institution; and (9) whether its membership is made up of coreligionists.[59] Depending on the facts, courts have found that Title VII's religious organization exemption applies not only to churches and other houses of worship, but also to religious schools, hospitals, and charities.[60]

Courts have expressly recognized that engaging in secular activities does not disqualify an employer from being a "religious organization" within the meaning of

the Title VII statutory exemption. “[R]eligious organizations may engage in secular activities without forfeiting protection” under the Title VII statutory exemption.^[61]

The Title VII statutory exemption provisions do not mention nonprofit and for-profit status.^[62] Title VII case law has not definitively addressed whether a for-profit corporation that satisfies the other factors can constitute a religious corporation under Title VII.^[63]

Where the religious organization exemption is asserted by a respondent employer, the Commission will consider the facts on a case-by-case basis; no one factor is dispositive in determining if a covered entity is a religious organization under Title VII’s exemption.

Scope of Religious Organization Exemption. Section 702(a) states, “[t]his subchapter shall not apply to . . . a religious corporation, association, educational institution, or society . . . with respect to the employment of individuals of a particular religion to perform work connected with the carrying on . . . of its activities.”^[64] Religious organizations are subject to the Title VII prohibitions against discrimination on the basis of race, color, sex, national origin (as well as the anti-discrimination provisions of the other EEO laws such as the ADEA, ADA, and GINA), and may not engage in related retaliation.^[65] However, sections 702(a) and 703(e)(2)^[66] allow a qualifying religious organization to assert as a defense to a Title VII claim of discrimination or retaliation that it made the challenged employment decision on the basis of religion.^[67] The definition of “religion” found in section 701(j) is applicable to the use of the term in sections 702(a) and 703(e)(2), although the provision of the definition regarding reasonable accommodations is not relevant.^[68]

Courts have held that the religious organization’s assertion that the challenged employment decision was made on the basis of religion is subject to a pretext inquiry where the employee has the burden to prove pretext.^[69] Courts also have held that any inquiry into the pretext of a religious organization’s rationale for its decision must be limited to “sincerity” and cannot be used to challenge the validity or plausibility of the underlying religious doctrine.^[70] For example, one court has held that a religious organization could not justify denying insurance benefits only to married women by asserting a religiously based view that only men could be the head of a household when evidence of practice inconsistent with such a belief established “conclusive[ly]” that the employer’s religious justification was “pretext” for sex discrimination.^[71]

In *EEOC v. Mississippi College*, the court held that if a religious institution presents “convincing evidence” that the challenged employment practice resulted from discrimination on the basis of religion, section 702 “deprives the EEOC of jurisdiction to investigate further to determine whether the religious discrimination was a pretext for some other form of discrimination.”^[72] Despite the court’s use of “jurisdiction” here, it has been held in light of the Supreme Court’s decision in *Arbaugh v. Y & H Corp.*, that Title VII’s religious organization exemptions are not jurisdictional.^[73]

The religious organization exemption is not limited to jobs involved in the specifically religious activities of the organization.^[74] Rather, “the explicit exemptions to Title VII . . . enable religious organizations to create and maintain communities composed solely of individuals faithful to their doctrinal practices, whether or not every individual plays a direct role in the organization’s ‘religious activities.’”^[75] In addition, the exemption allows religious organizations to prefer to employ individuals who share their religion, defined not by the self-identified religious affiliation of the employee, but broadly by the employer’s religious observances, practices, and beliefs.^[76] Consistent with applicable EEO laws, the prerogative of a religious organization to employ individuals “‘of a particular religion’ . . . has been interpreted to include the decision to terminate an employee whose conduct or religious beliefs are inconsistent with those of its employer.”^[77] Some courts have held that the religious organization exemption can still be established notwithstanding actions such as holding oneself out as an equal employment opportunity employer or hiring someone of a different religion for a position.^[78]

EXAMPLE 7

Religious Organization Exemption Applies

Justina taught mathematics at a small Catholic college, which requires all employees to agree to adhere to Catholic doctrine. After she signed a pro-choice advertisement in the local newspaper, the college terminated her employment because of her public support of a position in violation of Church doctrine. Justina claimed sex discrimination, alleging that male professors were treated less harshly for other conduct that violated Church doctrine. Because the exemption to Title VII preserves the religious school’s ability to

maintain a community composed of individuals faithful to its doctrinal practices, and because evaluating Justina's discipline compared to the male professors, who engaged in different behavior, would require the court to compare the relative severity of violations of religious doctrines, Title VII's religious organization exemption bars adjudication of the sex discrimination claim.^[79] The analysis would be different if a male professor at the school signed the same advertisement and was not terminated, because "[r]equiring a religious employer to explain why it has treated two employees who have committed essentially the same offense differently poses no threat to the employer's ability to create and maintain communities of the faithful."^[80]

2. Ministerial Exception

In *Hosanna-Tabor Evangelical Lutheran Church and School v. EEOC*,^[81] the Supreme Court "unanimously recognized that the Religion Clauses [of the First Amendment] foreclose certain employment-discrimination claims brought against religious organizations."^[82] The Court held that the First Amendment safeguards the right of a religious organization, free from interference from civil authorities, to select those who will "personify its beliefs," "shape its own faith and mission," or "minister to the faithful."^[83] This rule is known as the "ministerial exception," apparently because "the individuals involved in pioneering cases were described as 'ministers,'"^[84] but as discussed below, the exception is not limited to "ministers" or members of the clergy. The rule provides "an affirmative defense to an otherwise cognizable claim, not a jurisdictional bar."^[85]

The exception applies to discrimination claims involving selection, supervision, and removal against a religious institution by employees who "play certain key roles."^[86] "The constitutional foundation" of the Court's holding in *Hosanna-Tabor* was "the general principle of church autonomy."^[87] "Among other things, the Religion Clauses protect the right of churches and other religious institutions to decide matters 'of faith and doctrine' without government intrusion."^[88] The First Amendment "outlaws" such intrusion because "[s]tate interference in that sphere would obviously violate the free exercise of religion, and any attempt by government to dictate or even to influence such matters would constitute one of the central attributes of an establishment of religion."^[89] "This does not mean that religious institutions enjoy a general immunity from secular laws, but it does protect

their autonomy with respect to internal management decisions that are essential to the institution's central mission.”^[90]

A “religious institution” for purposes of the ministerial exception is one whose “mission is marked by clear or obvious religious characteristics.”^[91] Like Title VII’s religious organization exemption, courts have applied the ministerial exception to religious employers beyond churches and other houses of worship.^[92] But unlike the statutory religious organization exemption, the ministerial exception applies regardless of whether the challenged employment decision was for “religious” reasons.^[93]

As the Supreme Court stated in *Our Lady of Guadalupe School v. Morrissey-Berru*, the ministerial exception applies to employees who perform “vital religious duties” at the core of the mission of the religious institution.^[94] The Supreme Court in *Hosanna-Tabor* declined to adopt a “rigid formula”^[95] for deciding when the ministerial exception applies. Instead, in deciding whether a Lutheran school teacher’s retaliation claim was barred by the ministerial exception, the Supreme Court looked to “all the circumstances of her employment,” recognizing four “considerations” or “circumstances that [it] found relevant in that case”: (1) the employee’s formal title; (2) education or training; (3) the employee’s own use of the title; and (4) the “important religious functions” the employee performed.^[96] The Court further explained that, while relevant, “a title, by itself, does not automatically ensure coverage,”^[97] and that the title “minister” is not “a necessary requirement,” cautioning against “attaching too much significance to titles.”^[98] Relatedly, while academic requirements are relevant, “insisting in every case on rigid academic requirements could have a distorting effect” and “judges have no warrant to second-guess [a religious institution’s qualification] judgment or to impose their own credentialing requirements.”^[99] The Court rejected the view that the ministerial exception “should be limited to those employees who perform exclusively religious functions” and cautioned against placing too much emphasis on the performance of secular duties or the time spent on those duties.^[100]

In *Our Lady of Guadalupe School*, the Court reiterated that the four “considerations” relevant in *Hosanna-Tabor* are not intended to constitute a four-factor test because “a variety of factors may be important.”^[101] The Court explained that *Hosanna-Tabor* directs “courts to take all relevant circumstances into account and to determine whether each particular position implicated the fundamental purpose of the exception.”^[102] The circumstances that were instructive in *Hosanna-Tabor* are not

“inflexible requirements” and may have “far less significance in some cases” because “[w]hat matters, at bottom, is what an employee does.”^[103]

The religious institution’s “definition and explanation” of an employee’s role “in the life of the religion in question is important.”^[104] The ministerial exception is not limited to the head of a religious congregation, leaders, ministers, or members of the clergy, and can apply to “lay” employees and even non-“co-religionists” or those not “practicing” the faith.^[105] Courts have applied the ministerial exception in cases involving parochial school teachers,^[106] church musicians,^[107] and other employees who perform religious functions.^[108]

In *Our Lady of Guadalupe*, the Court explained that for a private religious school, “educating and forming students in the faith,” “inculcating its teachings, and training [students] to live their faith are responsibilities that lie at the very core of the mission” and “the selection and supervision of the teachers” who do this work are necessarily core elements of achieving the mission.^[109] The Court declined to “draw a critical distinction between a person who “simply relay[s] religious tenets” and one who relays such tenets while also “minister[ing] to the faithful,” but noted that a teacher of “world religions,” “who merely provides a description of the beliefs and practices of a religion without making any effort to inculcate those beliefs could not qualify for the exception.”^[110]

In holding that the ministerial exception barred employment discrimination claims by two elementary school teachers in Roman Catholic schools in *Our Lady of Guadalupe*, the Court found abundant evidence that the teachers “performed vital religious duties,” including: their employment contracts required them to carry out the schools’ religious mission and specified “that their work would be evaluated to ensure that they were fulfilling that responsibility”; their job duties required them to teach all subjects, including religion; they prepared their students for participation in religious activities, prayed with them, and attended Mass with them; and, they were the staff members “entrusted most directly with the responsibility of educating their students in the faith,” which included teaching them about the Catholic faith and guiding them “by word and deed, toward the goal of living their lives in accordance with the faith.”^[111] Therefore, even though the teachers each lacked a religious title and the religious training possessed by the teacher in *Hosanna-Tabor*, their core responsibilities as teachers of religion were essentially the same as hers, and “their schools expressly saw them as playing a vital role in carrying out the mission of the church.”^[112]

The ministerial exception is not just a legal defense that can be raised by religious institutions, but a constitutionally-based guarantee that obligates the government and the courts to refrain from interfering or entangling themselves with religion.^[113] As such, it should be resolved at the earliest possible stage before reaching the underlying discrimination claim.^[114] Some courts have held that the ministerial exception is not waivable.^[115]

3. Additional Interaction of Title VII with the First Amendment and the Religious Freedom Restoration Act (RFRA)

As noted above, the ministerial exception is based on the interaction between the workplace and the First Amendment. The applicability and scope of other defenses based on Title VII's interaction with the First Amendment or the Religious Freedom Restoration Act (RFRA) is an evolving area of the law. ^[116] It is not within the scope of this document to define the parameters of the First Amendment or RFRA. However, these provisions are referenced throughout this document to illustrate how they arise in Title VII cases and how courts have analyzed them. For example:

- a private sector employer or a religious organization might argue that its rights under the First Amendment's Free Exercise or Free Speech Clauses, or under RFRA, would be violated if it is compelled by Title VII to grant a particular accommodation or otherwise refrain from enforcing an employment policy; ^[117]
- a government employer might argue that granting a requested religious accommodation would pose an undue hardship because it would violate the Establishment Clause of the First Amendment; ^[118]
- some government employees might argue that their religious expression is protected by the First Amendment, RFRA, and/or Title VII; ^[119] and,
- some government employees raise claims under the First Amendment or RFRA parallel to their Title VII accommodation claims; ^[120] to date, appellate courts have uniformly held that Title VII preempts federal employees from bringing RFRA claims against their agency employer. ^[121]

Courts addressing the overlap between EEO laws and rights under RFRA and the Free Exercise Clause have stressed the importance of a nuanced balancing of potential burdens on religious expression, the governmental interests at issue, and how narrowly tailored the challenged government requirements are. ^[122]

NOTE: EEOC investigators must take great care in situations involving both (a) the statutory rights of employees to be free from discrimination at work, and (b) the rights of employers under the First Amendment and RFRA. Although a resolution satisfactory to all may come from good faith on the part of the employer and employee through mutual efforts to reach a reasonable accommodation, on occasion the religious interests of the employer and employee may be in conflict. EEOC personnel should seek the advice of the EEOC Legal Counsel in such a situation, and on occasion the Legal Counsel may consult as needed with the U.S. Department of Justice.

12-II EMPLOYMENT DECISIONS

A. General

Title VII's prohibition against discrimination based on religion generally functions like its prohibition against discrimination based on race, color, sex, or national origin. Absent a defense, disparate treatment violates the statute whether motivated by bias against or preference toward an applicant or employee due to his religious beliefs, practices, or observances – or lack thereof. Thus, for example, except to the extent an exemption, exception, or defense applies, an employer may not refuse to recruit, hire or promote individuals of a certain religion, may not impose stricter promotion requirements for persons of a certain religion, and may not impose more or different work requirements on an employee because of that employee's religious beliefs or practices.^[123] The following subsections address work scenarios that may lead to claims of religious discrimination.

1. Recruitment, Hiring, and Promotion

Employers that are not religious organizations may neither recruit indicating a preference for individuals of a particular religion nor adopt recruitment practices, such as word-of-mouth recruitment, that have the purpose or effect of discriminating based on religion.^[124] Title VII permits employers that are not religious organizations to recruit, hire and employ employees on the basis of religion only if religion is “a bona fide occupational qualification reasonably necessary to the normal operation of that particular business or enterprise.”^[125]

For example, other than as discussed above with respect to the religious organization and ministerial exceptions discussed above, an employer may not

refuse to hire an applicant simply because the applicant does not share the employer's religious beliefs, and conversely may not select one applicant over another based on a preference for employees of a particular religion.^[126] Similarly, employment agencies may not comply with requests from employers to engage in discriminatory recruitment or referral practices, for example by screening out applicants who have names often associated with a particular religion (e.g., Mohammed).^[127] Moreover, an employer may not exclude an applicant from hire merely because the applicant may need a reasonable accommodation for his or her religious beliefs, observances, or practices that could be provided absent undue hardship.^[128]

EXAMPLE 8

Recruitment

Charles, the president of a company that owns several gas stations, needs managers for the new convenience stores he has decided to add to the stations. He posts a job announcement at the Hindu Temple he attends expressing a preference for Hindu employees. In doing so, Charles is engaging in unlawful discrimination.^[129]

EXAMPLE 9

Hiring

A. Mary is a human resources officer who is filling a vacant administrative position at her company. During the application process, she performs an Internet search on the candidates and learns that one applicant, Jonathan, has written an article in which he describes himself as an Evangelical Christian and discusses how important his Christian faith is to all aspects of his life. Although Mary believes he is the most qualified candidate, she does not hire him because she knows that the company prefers to have a "secular" work environment and she thinks that most of the company's employees will find working with someone so religious "weird." Therefore, Mary decides that it is best not to hire Jonathan. By not hiring Jonathan because of his religion, the company violated Title VII.

B. Aatma, an applicant for a rental car sales position who is an observant Sikh, wears a dastar (religious headscarf) to her job interview. The interviewer does not advise her that there is a dress code prohibiting head coverings, and Aatma does not ask whether she would be permitted to wear the headscarf if she were hired. The manager knew or suspected the headscarf was a religious garment, presumed it would be worn at work, and refused to hire her because the company requires sales agents to wear a uniform with no additions or exceptions. Unless the employer can demonstrate that no reasonable accommodation was possible absent undue hardship, this refusal to hire violates Title VII, even though Aatma did not make a request for accommodation at the interview, because the employer believed her practice was religious and that she would need accommodation, and did not hire her for that reason.^[130]

C. A company's policy bars any employees from working in customer contact positions if they have a beard or wear a headcovering, and requests for religious accommodations are always denied. As a result of this policy and practice, individuals who wear beards or headcoverings pursuant to a religious belief work in lower-paying positions or positions with less opportunity for advancement. This would constitute limiting, segregating, or classifying based on religion in violation of Title VII, and may also have an unlawful disparate impact based on religion if it is not job-related and consistent with business necessity.^[131]

EXAMPLE 10

Promotion

Darpak, who practices Buddhism, holds a Ph.D. degree in engineering and applied for a managerial position at the research firm where he has worked for ten years. He was rejected in favor of a non-Buddhist candidate who was less qualified. The company vice president who made the promotion decision advised Darpak that he was not selected because "we decided to go in a different direction." However, the vice president confided to coworkers at a social function that he did not select Darpak because he thought a Christian manager could make

better personal connections with the firm's clients, many of whom are Christian. The vice president's statement, combined with the lack of any legitimate non-discriminatory reason for selecting the less qualified candidate, as well as the evidence that Darpak was the best qualified candidate for the position, suggests that the proffered reason was a pretext for discrimination against Darpak because of his religion.**[132]**

2. Discipline and Discharge

Title VII also prohibits employers from disciplining or discharging employees because of their religion.**[133]**

EXAMPLE 11

Discipline

Joanne, a retail store clerk, is frequently 10-15 minutes late for her shift on several days per week when she attends Mass at a Catholic church across town. Her manager, Donald, has never disciplined her for this tardiness, and instead filled in for her at the cash register until she arrived, stating that he understood her situation. On the other hand, Yusef, a newly hired clerk who is Muslim, is disciplined by Donald for arriving 10 minutes late for his shift even though Donald knows it is due to his attendance at services at the local mosque. While Donald can require all similarly situated employees to be punctual, he is engaging in disparate treatment based on religion by disciplining only Yusef and not Joanne absent a legitimate nondiscriminatory reason for treating them differently.

A charge alleging the above facts might involve denial of reasonable accommodation if the employee had requested a schedule adjustment. While the employer may require employees to be punctual and request approval of schedule changes in advance,**[134]** it may have to accommodate an employee who seeks leave or a schedule change to resolve the conflict between religious services and a work schedule, unless the accommodation would pose an undue hardship.

3. Compensation and Other Terms, Conditions, or Privileges of

Employment

Title VII prohibits discrimination on a protected basis “with respect to . . . compensation, terms, conditions, or privileges of employment,” for example, setting or adjusting wages, granting benefits, and/or providing leave in a discriminatory fashion.**[135]**

EXAMPLE 12

Wages and Benefits

Janet, who practices Native American spirituality, is a newly hired social worker for an agency. As a benefit to its employees, the agency provides tuition reimbursement for professional continuing education courses offered by selected providers. Janet applied for tuition reimbursement for an approved course that was within the permitted cost limit. Janet’s supervisor denied her request for tuition reimbursement, stating that since Janet believes in “voodoo” she “won’t make a very good caseworker.” By refusing, because of Janet’s religious beliefs, to provide the tuition reimbursement to which Janet was otherwise entitled as a benefit of her employment, Janet’s supervisor has discriminated against Janet on the basis of religion in violation of Title VII.

Title VII’s prohibition on disparate treatment based on religious beliefs also can apply to disparate treatment of religious expression in the workplace.**[136]**

EXAMPLE 13

Religious Expression

Eve is a secretary who displays a Bible on her desk at work. Xavier, a secretary in the same workplace, begins displaying a Quran on his desk at work. Their supervisor allows Eve to retain the Bible but directs Xavier to put the Quran out of view because, he states, coworkers “will think you are making a political statement, and with

everything going on in the world right now we don't need that around here." This differential treatment of similarly situated employees with respect to the display of a religious item at work constitutes religious discrimination.^[137]

Charges involving religious expression may involve not only allegations of differential treatment but also of harassment and/or denial of reasonable accommodation. Investigation of allegations of harassment and denial of reasonable accommodation are addressed respectively in §§ 12-III and 12-IV of this document. As discussed in greater detail in those sections, Title VII requires employers to accommodate expression that is based on a sincerely held religious practice or belief, unless it threatens to constitute harassment^[138] or poses an "undue hardship" on the conduct of the business.^[139] An employer can thus restrict religious expression when it would disrupt customer service or the workplace, including when customers or coworkers would reasonably perceive it to express the employer's own message.^[140] *For further discussion of how to analyze when accommodation of religious expression would pose an undue hardship, refer to the sections on Harassment at § 12-III-C and Accommodation at § 12-IV-C-6.*

B. Customer Preference

An employer's action based on the discriminatory preferences of others, including coworkers or customers, is unlawful.^[141]

EXAMPLE 14

Employment Decision Based on Customer Preference

Harinder, who wears a turban as part of his Sikh religion, is hired to work at the counter in a coffee shop. A few weeks after Harinder begins working, the manager notices that the work crew from the construction site near the shop no longer comes in for coffee in the mornings. When he inquires, the crew complains that Harinder, whom they mistakenly believe is Muslim, makes them uncomfortable in light of the September 11th attacks. The manager tells Harinder that he has to let him go because the customers' discomfort is understandable. The manager has subjected Harinder to unlawful religious discrimination by taking an adverse action based on

customers' preference not to have a cashier of Harinder's perceived religion. Harinder's termination based on customer preference would violate Title VII regardless of whether he was – or was misperceived to be -- Muslim, Sikh, or any other religion.

C. Security Requirements

In general, an employer may adopt security requirements for its employees or applicants, provided they are adopted for nondiscriminatory reasons and are applied in a nondiscriminatory manner. For example, an employer may not require Muslim applicants to undergo a background investigation or more extensive security procedures because of their religion without imposing the same requirements on similarly situated applicants who are non-Muslim.^[142]

D. Bona Fide Occupational Qualification

Title VII permits employers to hire and employ employees on the basis of religion if religion is “a bona fide occupational qualification [“BFOQ”] reasonably necessary to the normal operation of that particular business or enterprise.”^[143] Religious organizations do not typically need to rely on this BFOQ defense because the “religious organization” exemption in Title VII permits them to prefer employees of a particular religion. See *supra* § 12-I-C-1. But for employers that are not religious organizations and seek to rely on the BFOQ defense to justify a religious preference, the defense is a narrow one and rarely successfully invoked.^[144]

• Employer Best Practices •

- Employers can reduce the risk of discriminatory employment decisions by establishing written objective criteria for evaluating candidates for hire or promotion and applying those criteria consistently to all candidates.
- In conducting job interviews, employers can ensure nondiscriminatory treatment by asking the same questions of all applicants for a particular job or category of job and inquiring about matters directly related to the position in question.
- Employers can reduce the risk of religious discrimination claims by carefully and timely recording the accurate business reasons for disciplinary or

performance-related actions and sharing these reasons with the affected employees.

- When management decisions require the exercise of subjective judgment, employers can reduce the risk of discriminatory decisions by providing training to inexperienced managers and encouraging them to consult with more experienced managers or human resources personnel when addressing difficult issues.
- If an employer is confronted with customer biases, e.g., an adverse reaction to being served by an employee due to religious garb, the employer should consider engaging with and educating the customers regarding any misperceptions they may have and/or the equal employment opportunity laws.

12-III HARASSMENT

Overview: Religious harassment is analyzed and proved in the same manner as harassment based on other traits protected by Title VII—race, color, sex, and national origin. However, the facts of religious harassment cases may present unique considerations, especially where the alleged harassment is based on another employee’s religious practices. Such a situation may require an employer to reconcile its dual obligations to take prompt remedial action in response to alleged harassment and to accommodate certain employee religious expression.

A. Prohibited Conduct

As stated, Title VII makes it “an unlawful employment practice for an employer . . . to discriminate against any individual with respect to his compensation, terms, conditions, or privileges of employment, because of such individual’s race, color, religion, sex, or national origin.”^[145] “[A]lthough [Title VII] mentions specific employment decisions with immediate consequences, the scope of the prohibition is not limited to economic or tangible discrimination” and “covers more than terms and conditions in the narrow contractual sense.”^[146] Title VII covers “environmental claims” as well,^[147] including “harassment leading to

noneconomic injury,”^[148] but the conduct must be “sufficiently severe or pervasive ‘to alter the conditions of [the victim’s] employment and create an abusive working environment.’”^[149]

B. Types of Harassment Claims

The same Title VII principle applies whether the harassment is based on race, color, national origin, religion, or sex.^[150] Like harassment based on other protected characteristics, religious harassment can take the form of (1) outright coercion, or an economic “quid pro quo,” in which the employee is pressured or coerced to abandon, alter, or adopt a religious practice as a condition of employment;^[151] or of (2) a hostile work environment, in which the employee is subjected to unwelcome, religiously based statements or conduct so severe or pervasive that the employee objectively and subjectively finds the work environment to be hostile or abusive.^[152] Employer liability for harassment is discussed below in § 12-III-B.

1. Religious Coercion

Title VII is violated when an employer or supervisor explicitly or implicitly coerces an employee to abandon, alter, or adopt a religious practice as a condition of receiving a job benefit or privilege or avoiding an adverse employment action.^[153]

EXAMPLE 15

Religious Conformance Required for Promotion

Wamiq was raised as a Muslim but no longer practices Islam. His supervisor, Arif, is a very devout Muslim who tries to persuade Wamiq not to abandon Islam and advises him to follow the teachings of the Quran. Arif also says that if Wamiq expects to advance in the company, he should join Arif and other Muslims for weekly prayer sessions in Arif’s office. Notwithstanding this pressure to conform his religious practices in order to be promoted, Wamiq refuses to attend the weekly prayer sessions, and is subsequently denied the promotion for which he applied even though he is the most qualified. Arif’s conduct indicates that the promotion would have been granted if Wamiq had participated in the prayer sessions and had become an observant Muslim. Absent contrary evidence, the employer will be

liable for harassment for conditioning Wamiq's promotion on his adherence to Arif's views of appropriate religious practice.^[154]

Not promoting Wamiq would also be actionable as disparate treatment based on religion, unless the employer could demonstrate a non-religiously based, non-pretextual reason for denying Wamiq the promotion. In addition, if Arif had made the prayer sessions mandatory and Wamiq had asked to be excused on religious grounds, Arif would have been required to excuse Wamiq from the prayer sessions as a reasonable accommodation.

A claim of harassment based on coerced religious participation or non-participation, however, only arises where it was intended to make the employee conform to or abandon a religious belief or practice. By contrast, an employer would not violate Title VII if it required an employee to participate in a workplace activity that conflicts with the employee's sincerely held religious belief if the employee does not request to be excused or if the employer demonstrates that accommodating the employee's request to be excused would pose an undue hardship.^[155] The same fact pattern may give rise to allegations of disparate treatment, harassment, and/or denial of accommodation. For example, terminating rather than accommodating an employee may give rise to allegations of both denial of accommodation and discriminatory discharge.^[156] For discussion of the accommodation issue, see § 12-IV.

2. Hostile Work Environment

Title VII's prohibition against religious discrimination includes prohibiting a hostile work environment because of religion. An unlawful hostile environment based on religion can take the form of physical or verbal harassment, which would include the unwelcome imposition of beliefs or practices contrary to the employee's religion or lack thereof. A hostile work environment is created "[w]hen the workplace is permeated with discriminatory intimidation, ridicule, and insult that is sufficiently severe or pervasive to alter the conditions of the victim's employment and create an abusive working environment."^[157] To establish a case of religious hostile work environment harassment, an employee must show: (1) that the harassment was based on his religion; (2) that the harassment was unwelcome; (3) that the harassment was sufficiently severe or pervasive to alter the conditions of employment by creating an objectively and subjectively hostile or abusive work environment; and (4) that there is a basis for employer liability.^[158]

a. Based on Religion

To support a religious harassment claim, the adverse treatment must be based on the employee's religion.^[159] While verbally harassing conduct clearly is based on religion if it has religious content, harassment can also be based on religion even if religion is not explicitly mentioned.^[160]

EXAMPLE 16**Harassing Conduct Based on Religion – Religion Mentioned**

Mohammed is an Indian-born Muslim employed at a car dealership. Because he takes scheduled prayer breaks during the workday and observes Muslim dietary restrictions, his coworkers are aware of his religious beliefs. Upset by the anniversary of the 9/11 terrorist attacks, his coworkers and managers began making mocking comments about his religious dietary restrictions and need to pray during the workday. They repeatedly referred to him as “Taliban” or “Arab” and asked him “why don’t you just go back where you came from since you believe what you believe?” When Mohammed questioned why it was mandatory for all employees to attend a United Way meeting, his supervisor said: “This is America. That’s the way things work over here. This is not the Islamic country where you come from.” After this confrontation, the supervisor issued Mohammed a written warning stating that he “was acting like a Muslim extremist” and that the supervisor could not work with him because of his “militant stance.” This harassment is based on religion and national origin.^[161]

EXAMPLE 17**Harassing Conduct Based on Religion – Religion Not Mentioned**

Shoshanna is a Seventh-day Adventist whose work schedule was adjusted to accommodate her Sabbath observance, which begins at sundown each Friday. When Nicholas, the new head of Shoshanna’s department, was informed that he must accommodate her, he told a colleague that “anybody who cannot work regular hours should work

elsewhere.” Nicholas then moved the regular Monday morning staff meetings to late Friday afternoon, repeatedly scheduled staff and client meetings on Friday afternoons, and often marked Shoshanna AWOL when she was not scheduled to work. In addition, Nicholas treated her differently than her colleagues by, for example, denying her training opportunities and loudly berating her with little or no provocation. Although Nicholas did not mention Shoshanna’s religion, the evidence shows that his conduct was because of Shoshanna’s need for religious accommodation, and therefore was based on religion.^[162]

b. Unwelcome

Conduct is “unwelcome” when “it is uninvited and offensive or unwanted from the standpoint of the employee.”^[163] It is not necessary in every case for the harassed employee to explicitly voice objection to the conduct (e.g., to confront the alleged harasser contemporaneously) for the conduct to be deemed unwelcome. In addition, since 1993 when the Supreme Court decided *Harris v. Forklift Systems, Inc.*, and added “subjective hostility” to the hostile work environment analysis, some courts have found that the analysis of “unwelcomeness” and “subjective hostility” overlap.^[164] For example, where an employee is visibly upset by repeated mocking use of derogatory terms or comments about his religious beliefs or observance by a colleague, it may be evident that the conduct is unwelcome and also subjectively hostile.^[165] This would stand in contrast to a situation where the same two employees were engaged in a consensual conversation that involves a spirited debate of religious views, but neither employee indicates to the other, or to the employer, that he or she is upset by it. For a discussion on reporting to the employer, see *infra* § 12-III-B.

The distinction between welcome and unwelcome conduct is especially important in the religious context in situations involving proselytizing to employees who have not invited such conduct. Where a religious employee attempts to persuade another employee of the correctness of his or her belief, the conduct may or may not be welcome. When an employee expressly objects to particular religious expression, unwelcomeness is evident.^[166]

EXAMPLE 18

Unwelcome Conduct

Beth's colleague, Bill, repeatedly talked to her at work about her prospects for salvation. For several months, she did not object and discussed the matter with him. When he persisted even after she told him that he had "crossed the line" and should stop having non-work-related conversations with her, the conduct was clearly unwelcome.
^[167]

c. Severe or Pervasive

Harassment is actionable if, as a whole, the conduct is "sufficiently severe or pervasive 'to alter the conditions of [the victim's] employment and create an abusive working environment.'" As the Supreme Court explained with respect to Title VII in *Harris v. Forklift Systems, Inc.*, 510 U.S. at 21:

Conduct that is not severe or pervasive enough to create an objectively hostile or abusive work environment—an environment that a reasonable person would find hostile or abusive—is beyond Title VII's purview. Likewise, if the victim does not subjectively perceive the environment to be abusive, the conduct has not actually altered the conditions of the victim's employment, and there is no Title VII violation.

Thus, harassing conduct based on the employee's religion is actionable when it is sufficiently severe or pervasive to create an objectively and subjectively hostile work environment. A hostile work environment claim may encompass any hostile conduct that affects the complainant's work environment, including employer conduct that may be independently actionable. Whether a reasonable person would perceive the conduct as abusive turns on common sense and context, looking at the totality of the circumstances.^[168] All of the alleged incidents must be "considered cumulatively in order to obtain a realistic view of the work environment."^[169] Relevant factors "may include the frequency of the discriminatory conduct; its severity; whether it is physically threatening or humiliating, or merely an offensive utterance; and whether it unreasonably interferes with an employee's work performance."^[170] But "no single factor is required."^[171]

EXAMPLE 19

Reasonable Person Perceives Conduct to Be Hostile

The president of Printing Corp. regularly mocked and berated an employee who asked for Sundays off to attend Mass. Although he granted the time off, the president teased the employee for refusing to look at a Playboy magazine, called him a “religious freak,” and used vulgar sexual language when speaking to or about the employee. He mocked him for “following the Pope around” and made sexual comments about the Virgin Mary. A reasonable person could perceive this to be a religiously hostile work environment.^[172]

To “alter the conditions of employment,” conduct need not cause economic or psychological harm.^[173] It also need not impair work performance, discourage employees from remaining on the job, or impede their advancement.^[174] The presence of one or more of these factors would buttress the claim, but is not required. **[175]**

However, Title VII is not a “general civility code,” and does not render all insensitive or offensive comments, petty slights, and annoyances illegal.^[176] Isolated incidents (unless extremely serious) will not rise to the level of illegality.^[177]

EXAMPLE 20**Insensitive Comments Not Enough to Constitute Hostile Environment**

Marvin is an Orthodox Jew who was hired as a radio show host. When he started work, a coworker, Stacy, pointed to his yarmulke and asked, “Will your headset fit over that?” On a few occasions, Stacy made other remarks about the yarmulke, such as: “Nice hat. Is that a beanie?” and “Do they come in different colors?” Although the coworker’s comments about his yarmulke were insensitive, they were not, standing alone, sufficiently severe or pervasive to create a hostile work environment for Marvin.^[178]

EXAMPLE 21

Isolated Comments Not Enough to Constitute Hostile Environment

Bob, a supervisor, occasionally allowed spontaneous and voluntary prayers by employees during office meetings. During one meeting, he referenced Bible passages related to “slothfulness” and “work ethics.” Amy complained that Bob’s comments and the few instances of allowing voluntary prayers during office meetings created a hostile environment. The comments did not create an actionable harassment claim. They were not severe, and because they occurred infrequently, they were not sufficiently pervasive to state a claim.^[179]

Severity and pervasiveness need not both be present, and they operate inversely. The more severe the harassment, the less frequently the incidents need to recur. At the same time, incidents that may not, individually, be severe may become unlawful if they occur frequently or in proximity.^[180]

Although a single incident will seldom create an unlawfully hostile environment, it may do so if it is unusually severe, such as where it involves a physical threat.^[181]

EXAMPLE 22**One Instance of Physically Threatening Conduct Sufficiently Severe**

Ihsaan is a Muslim. Shortly after the terrorist attacks on September 11, 2001, Ihsaan came to work and found the words “I’m tired of you Muslims. You’re all terrorists! We will avenge the victims!! Your life is next!” scrawled in red marker on his office door. Because of the timing of the statement and the direct physical threat, this incident, alone, is sufficiently severe to create an objectively hostile and/or abusive work environment.^[182]

EXAMPLE 23**Isolated Practices Not Enough to Constitute Hostile Environment**

Tran owns a restaurant serving Asian-fusion cuisine. The restaurant is decorated with Vietnamese art depicting scenes from traditional religious stories. Tran keeps a shrine of Buddha in the corner by the cash register and likes to play traditional Vietnamese music and chants. Linda has worked as a waitress in the restaurant for a few months and complains that she feels harassed by the religious symbols and music. As long as Tran does not discriminate on the basis of religion in his hiring or supervision of employees, the religious expression would likely not amount to practices that are severe or pervasive enough to constitute a hostile work environment based on religion.

EXAMPLE 24

Persistent Offensive Remarks Constitute Hostile Environment

Betty is a Mormon. During a disagreement regarding a joint project, a coworker, Julian, tells Betty that she doesn't know what she is talking about and that she should "go back to Salt Lake City." When Betty subsequently proposes a different approach to the project, Julian tells her that her suggestions are as "flaky" as he would expect from "her kind." When Betty tries to resolve the conflict, Julian tells her that if she is uncomfortable working with him, she can either ask to be transferred, or she can "just pray about it." Over the next six months, Julian regularly makes similar negative references to Betty's religion. His persistent offensive remarks create a hostile environment.

Religious expression that is directed at an employee can become severe or pervasive, whether or not the content is intended to be insulting or abusive. Thus, for example, persistently reiterating atheist views to a religious employee who has asked that it stop can create a hostile environment, just as persistently proselytizing to an atheist employee or an employee with different religious beliefs who has asked that it stop can create a hostile work environment. The extent to which the expression is directed at the employee bringing the Title VII claim can be relevant to determining whether or when a reasonable employee would have perceived it to be hostile.^[183] That said, even conduct that is not directed at an employee can transform a work environment into a hostile or abusive one.^[184]

A coworker having a difference of opinion with an employee's religious views does not establish a hostile work environment when there is no other evidence of harassment. This would include when a coworker disagrees with the religious views that an employee expresses outside of the workplace, for example on social media, when there is no evidence it is linked to the workplace.[185]

EXAMPLE 25

No Hostile Environment from Comments That Are Not Abusive and Not Directed at Complaining Employee

While eating lunch in the company cafeteria, Clarence often overhears conversations between his coworkers Dharma and Khema. Dharma, a Buddhist, is discussing meditation techniques with Khema, who is interested in Buddhism. Clarence strongly believes that meditation is an occult practice that offends him, and he complains to their supervisor that Dharma and Khema are creating a hostile environment for him. Such conversations taking place in the cafeteria do not constitute severe or pervasive religious harassment of Clarence, particularly given that they do not insult other religions and they were not directed at him.

C. Employer Liability

Overview: An employer is always liable for a supervisor's harassment if it results in a tangible employment action. If the supervisor's harassment does not result in tangible employment action, the employer may be able to avoid liability or limit damages by establishing an affirmative defense that includes two necessary elements: (a) the employer exercised reasonable care to prevent and correct promptly any harassing behavior, and (b) the employee unreasonably failed to take advantage of any preventive or corrective opportunities provided by the employer or to avoid harm otherwise. An employer is liable for a coworker's or non-employee's harassment in two circumstances: (a) if it unreasonably failed to prevent the harassment, or (b) if it knew or should have known about the harassment and failed to take prompt and appropriate corrective action.

An employer will be liable for a hostile work environment that an employee endures if vicarious liability under common law agency principles is found to apply.^[186] As explained more fully below, whether vicarious liability applies depends on the employment status of the harasser (i.e., a manager or coworker), whether a tangible employment action was the result of the harassment, the employer's policies, whether the employer was aware or should have been aware of the harassment, and what action, if any, the employer took when it learned of the harassment.

1. Harassment by Alter-Ego

Under agency-law principles, an employer is automatically liable for religious harassment by an agent, even if it does not result in a tangible employment action, if “the agent’s high rank in the company makes him or her the employer’s alter ego.”^[187] If the harasser is of a sufficiently high rank to fall “within that class of an employer organization’s officials who may be treated as the organization’s proxy,” which would include officials such as a company president, owner, partner, or corporate officer, the harassment is automatically imputed to the employer and the employer cannot assert the affirmative defense.^[188]

2. Harassment by Supervisors or Managers

Employers are automatically liable for religious harassment by a supervisor with authority over a plaintiff when the harassment results in a tangible employment action such as a denial of promotion, demotion, discharge, or undesirable reassignment.^[189] If the harassment by such a supervisor does not result in a tangible employment action, the employer can attempt to prove, as an affirmative defense to liability, that: (1) the employer exercised reasonable care to prevent and promptly correct any harassing behavior, and (2) the employee unreasonably failed to take advantage of any preventive or corrective opportunities provided by the employer or to otherwise avoid harm.^[190]

EXAMPLE 26

Supervisory Harassment with Tangible Employment Action

George, a manager in an accounting firm, is an atheist who has frequently been heard to say that he thinks anyone who is deeply religious is a zealot with his own agenda and cannot be trusted to act

in the best interests of the clients. George particularly ridicules Debra, a devoutly observant Jehovah's Witness, and consistently withholds the most desirable assignments from her. He denies her request for a promotion to a more prestigious job in another division, saying that he can't let her "spread that religious poppycock any further." Debra files a religious harassment charge. The firm asserts in its position statement that it is not liable because Debra never made a complaint under its internal anti-harassment policy and complaint procedures. Because the harassment was by a supervisor of Debra's and culminated in a tangible employment action (failure to promote), the employer is liable for the harassment even if it has an effective anti-harassment policy, and even if Debra never complained. If George is a "proxy" of the firm, then the firm is also liable for the harassment even in the absence of a tangible employment action. Additionally, the denial of promotion would be actionable as disparate treatment based on religion.

EXAMPLE 27

Supervisory Harassment Without Tangible Employment Action

Jennifer's employer, XYZ, had an anti-harassment policy and complaint procedure that covered religious harassment. All employees were aware of it because XYZ widely and regularly publicized it. Despite his knowledge of the policy, Jennifer's supervisor frequently mocked her religious beliefs. When Jennifer told him that his comments bothered her, he told her that he was just kidding and she should not take everything so seriously. Jennifer never reported the supervisor's conduct. When one of Jennifer's coworkers eventually reported the supervisor's harassing conduct under the employer's antiharassment procedure, the employer promptly investigated and acted effectively to stop the supervisor's conduct. Jennifer then filed a religious harassment charge. Because the harassment of Jennifer did not culminate in a tangible employment action, XYZ will not be liable for the harassment if it can show both that Jennifer's failure to utilize XYZ's available complaint mechanisms was unreasonable, and that XYZ exercised reasonable

care to prevent and promptly correct the harassment. The employer should be able to make the “promptly correct” showing, because it took prompt and reasonable corrective measures once it did learn of the harassment.^[191]

3. Harassment by Coworkers

An employer is liable for harassment by coworkers where the employer: (1) unreasonably failed to prevent the harassment;^[192] or (2) knew or should have known about the harassment, and failed to take prompt and appropriate corrective action.^[193]

EXAMPLE 28

Harassment by Coworkers

John, who is a Christian Scientist, shares an office with Rick, a Mormon. Rick repeatedly tells John that he is practicing a false religion, and that he should study Mormon literature. Despite John’s protestations that he is very happy with his religion and has no desire to convert, Rick regularly leaves religious pamphlets on John’s desk and tries to talk to him about religion. After asking Rick to stop the behavior to no avail, John complains to their immediate supervisor, who dismisses John’s complaint on the ground that Rick is a nice person who believes that he is just being helpful. If the harassment continues, the employer is liable because it knew, through the supervisor, about Rick’s harassing conduct but failed to take prompt and appropriate corrective action.^[194]

4. Harassment by Non-Employees

An employer is liable for harassment by non-employees where the employer: (1) unreasonably failed to prevent the harassment; or (2) knew or should have known about the harassment and failed to take prompt and appropriate corrective action.^[195]

EXAMPLE 29**Harassment by a Contractor**

Tristan works for XYZ, a contractor that manages Crossroads Corporation's mail room. When Tristan delivers the mail to Julia, the Crossroads receptionist, he gives her religious tracts, attempts to convert her to his religion, tells her that her current religious beliefs will lead her to Hell, and persists even after she tells him to stop. Julia reports Tristan's conduct to her supervisor, who tells her that he cannot do anything because Tristan does not work for Crossroads. If the harassment continues, the supervisor's failure to act is likely to subject Crossroads to liability because Tristan's conduct is severe or pervasive and based on religion, and Crossroads failed to take corrective action within its control after Julia reported the harassment. Options available to Julia's supervisor or the appropriate individual in the supervisor's chain of command might include initiating a meeting with Tristan and XYZ management regarding the harassment and demanding that it cease, that appropriate disciplinary action be taken if it continues, and/or that a different mail carrier be assigned to Julia's route.

D. Special Considerations for Employers When Balancing Anti-Harassment and Accommodation Obligations With Respect to Religious Expression

While some employees believe that religion is intensely personal and private, others are open about sharing or outwardly expressing their religion. In addition, there are employees who may believe that they have a religious obligation to share their views and to try to persuade coworkers of the truth of their religious beliefs, i.e., to proselytize. Certain private employers, too, whether or not they are religious organizations, may wish to express their religious views and share their religion with their employees.^[196] As noted above, however, some employees may perceive proselytizing or other religious expression as unwelcome based on their own religious beliefs and observances, or lack thereof. In an increasingly pluralistic society, the mix of divergent beliefs and practices can give rise to conflicts requiring employers to balance the rights of employers and employees who wish to express

their religious beliefs with the rights of other employees to be free from religious harassment under the foregoing Title VII harassment standards.

As discussed in more detail in § IV-C-6 of this document, an employer never has to accommodate expression of a religious belief in the workplace where such an accommodation could potentially constitute harassment of coworkers, because that would pose an undue hardship for the employer.^[197] Nor does Title VII require an employer to accommodate an employee's desire to impose his religious beliefs upon his coworkers.^[198] Therefore, while Title VII requires employers to accommodate an employee's sincerely held religious belief in engaging in religious expression (e.g. proselytizing) in the workplace, an employer does not have to allow such expression if it imposes an undue hardship on the operation of the business. For example, it would be an undue hardship for an employer to accommodate proselytizing by an employee if the proselytizing had adverse effects on employee morale or workplace productivity.

Because employers are responsible for maintaining a nondiscriminatory work environment, they can be held liable for perpetrating or tolerating religious harassment of their employees. An employer can reduce the chance that employees will engage in conduct that rises to the level of unlawful harassment by implementing an anti-harassment policy and an effective procedure for reporting, investigating, and correcting harassing conduct.^[199] Even if the policy does not prevent all such conduct, it could limit the employer's liability where the employee does not report conduct rising to the level of illegal harassment.

However, "[d]iscussion of religion in the workplace is not illegal."^[200] In fact, Title VII violations may result if an employer tries to avoid potential coworker objections to employee religious expression by preemptively banning all religious communications in the workplace or discriminating against unpopular religious views, since Title VII requires that employers not discriminate based on religion and that they reasonably accommodate employees' sincerely held religious observances, practices, and beliefs as long as accommodation poses no undue hardship.^[201]

• Employer Best Practices •

- Employers should have a well-publicized and consistently applied anti-harassment policy that: (1) covers religious harassment; (2) clearly explains what is prohibited; (3) describes procedures for bringing harassment to management's attention; and (4) contains an assurance that complainants will be protected against retaliation. The procedures should include a complaint mechanism that includes multiple avenues for complaint; prompt, thorough, and impartial investigations; and prompt and appropriate corrective action.
- Employers should encourage managers to intervene proactively and discuss whether particular religious expression is welcome if the manager believes the expression is likely to be construed as unwelcome to a reasonable person.
- Employers should allow religious expression among employees at least to the same extent that they allow other types of personal expression that are not harassing or disruptive to the operation of the business.^[202]
- Once an employer is on notice that religious expression by an employee is unwelcome to another employee, the employer should investigate and, if appropriate, take steps to ensure that the expression in question does not become sufficiently severe or pervasive to create a hostile work environment.
- If harassment is perpetrated by a non-employee assigned by a contractor, vendor, or client, the supervisor or other appropriate individual in the impacted employee's chain of command should initiate a meeting with the contractor, vendor, or client regarding the harassment and require that it cease, that appropriate disciplinary action be taken if it continues, and/or that a different individual be assigned.
- To prevent conflicts from escalating to the level of a Title VII violation, employers should immediately intervene when they become aware of objectively abusive or insulting conduct, even absent a complaint.
- While supervisors are permitted to engage in certain religious expression, they should avoid expression that might – due to their supervisory authority – reasonably be perceived by subordinates as coercive, even when not so intended.

• Employee Best Practices •

- Where they feel comfortable doing so, employees who find harassing workplace religious conduct directed at them unwelcome should inform the

individual engaging in the conduct that they wish it to stop. If the conduct does not stop, employees should report it to their supervisor or other appropriate company official in accordance with the procedures established in the company's anti-harassment policy.

- Employees who do not wish personally to confront an individual who is engaging in unwelcome religious or anti-religious conduct should report the conduct to their supervisor or other appropriate company official in accordance with the company's anti-harassment policy.

12-IV REASONABLE ACCOMMODATION

Overview: Title VII requires an employer, once on notice, to reasonably accommodate an employee whose sincerely held religious belief, practice, or observance conflicts with a work requirement, unless providing the accommodation would create an undue hardship.^[203] The Title VII “undue hardship” defense is defined differently than the “undue hardship” defense for disability accommodation under the Americans with Disabilities Act (ADA). Title VII’s undue hardship defense to providing religious accommodation has been defined by the Supreme Court as requiring a showing that the proposed accommodation in a particular case poses “more than a *de minimis*” cost or burden. This is a lower standard for an employer to meet than undue hardship under the ADA, which is defined in that statute as “an action requiring significant difficulty or expense.”^[204]

“Title VII requires otherwise-neutral policies to give way to the need for an accommodation.”^[205] An individual alleging the denial of a religious accommodation is generally seeking an adjustment to a neutral work rule that infringes on the employee’s ability to practice his religion.^[206] “The accommodation requirement is ‘plainly intended to relieve individuals of the burden of choosing between their jobs and their religious convictions, where such relief will not unduly burden others.’”^[207]

A. Religious Accommodation

A religious accommodation is an adjustment to the work environment that will allow the employee to comply with his or her religious beliefs. An employer need not provide a reasonable accommodation if doing so would cause undue hardship on the conduct of the employer’s business, which the Supreme Court has interpreted to mean an accommodation that would require the employer to bear

more than a *de minimis* cost or burden.^[208] The employer's duty to accommodate will usually entail making a special exception from, or adjustment to, the particular requirement that creates a conflict so that the employee or applicant will be able to observe or practice his or her religion. Accommodation requests often relate to work schedules, dress and grooming, or religious expression or practice while at work.^[209] The Commission's position is that the denial of reasonable religious accommodation absent undue hardship is actionable even if the employee has not separately suffered an independent adverse employment action, such as being disciplined, demoted, or discharged as a consequence of being denied accommodation.^[210] This is because requiring him to work without religious accommodation where a work rule conflicts with his religious beliefs necessarily alters the terms and conditions of his employment for the worse.^[211] However, the courts are split on this question.^[212]

1. Notice of the Conflict Between Religion and Work

Employers need not provide an accommodation unless they are on notice that one is needed for religious purposes.^[213] Typically, the employer will advise the applicant or employee of its policies or a particular work requirement, and in response the applicant or employee will indicate that an accommodation is needed for religious reasons. In some instances, even absent an applicant's or employee's request, the employer will be on notice that the observance or practice is religious and conflicts with a work policy, and therefore that accommodation is or could be needed.^[214] In such circumstances, it would violate Title VII for an employer to fail to provide a reasonable accommodation unless it proves that doing so would pose an undue hardship.^[215]

In addition, even in the absence of any notice that a religious accommodation is needed, an employer violates Title VII if it takes an adverse action against an applicant or employee (such as failing to hire) based on its belief that the applicant or employee might need a reasonable religious accommodation, unless the employer proves that such an accommodation would have imposed an undue hardship.^[216]

When requesting accommodation, the applicant or employee need not use any "magic words," such as "religious accommodation" or "Title VII." The employer must have enough information to make the employer aware that there exists a conflict between the applicant's or employee's religious observance, practice, or belief and a requirement for applying for or performing the job.^[217] If the employer

reasonably needs more information, the employer and the applicant or employee should discuss the request. The applicant or employee may need to explain the religious nature of the belief, observance, or practice at issue, and cannot assume that the employer will already know or understand it.^[218] Similarly, the employer should not assume that a request is invalid simply because it is based on religious beliefs or practices with which the employer is unfamiliar, but should ask the applicant or employee to explain the religious nature of the practice and the way in which it conflicts with a work requirement. In determining if a conflict exists, it is irrelevant that the employer does not view the work requirement as implicating a religious belief, or that most people of the applicant's or employee's faith would not; it is the applicant's or employee's own religious beliefs that are relevant.^[219]

EXAMPLE 30

Failure to Advise Employer That Request Is Due to Religious Practice or Belief

Jim agreed to take his employer's drug test but was terminated because he refused to sign the accompanying consent form. After his termination, Jim filed a charge alleging that the employer failed to accommodate his religious objection to swearing an oath. Until it received notice of the charge, the employer did not know that Jim's refusal to sign the form was based on his religious beliefs. Because the employer was not notified of the conflict at the time Jim refused to sign the form, or at any time prior to Jim's termination, it did not have an opportunity to offer to accommodate him. The employer has not violated Title VII.^[220]

2. Discussion of Request

Although an employer is not required by Title VII to conduct a discussion with an employee before making a determination on an accommodation request, as a practical matter it can be important to do so. Both the employer and the employee have roles to play in resolving an accommodation request. In addition to placing the employer on notice of the need for accommodation, the employee should cooperate with the employer's efforts to determine whether a reasonable accommodation can be granted. Once the employer becomes aware of the

employee's religious conflict, the employer should obtain promptly whatever additional information is needed to determine whether a reasonable accommodation is available without posing an undue hardship on the operation of the employer's business.^[221] This typically involves the employer and employee mutually sharing information necessary to process the accommodation request. Employer-employee cooperation and flexibility are key to the search for a reasonable accommodation. If the accommodation solution is not immediately apparent, the employer should discuss the request with the employee to determine what accommodations might be effective. If the employer requests additional information reasonably needed to evaluate the request, the employee should provide it.

Failure to confer with the employee is not an independent violation of Title VII. But as a practical matter, such failure can have adverse legal consequences. For example, in some cases where an employer has made no effort to act on an accommodation request, courts have found that the employer lacked the evidence needed to meet its burden of proof to establish that the plaintiff's proposed accommodation would actually have posed an undue hardship.^[222]

Likewise, employees should cooperate with an employer's requests for reasonable information. For example, if an employee requested a schedule change to accommodate daily prayers, the employer might need to ask for information about the religious observance, such as the time and duration of the daily prayers, in order to determine if accommodation can be granted without posing an undue hardship on the operation of the employer's business. Moreover, even if the employer does not grant the employee's preferred accommodation but instead provides a reasonable alternative accommodation, the employee must cooperate by attempting to meet his religious needs through the employer's proposed accommodation if possible.^[223]

Where the accommodation request itself does not provide enough information to enable the employer to make a determination, and the employer has a bona fide doubt as to the basis for the accommodation request, it is entitled to make a limited inquiry into the facts and circumstances of the employee's claim that the belief or practice at issue is religious and sincerely held, and that the belief or practice gives rise to the need for the accommodation.^[224] Whether an employer has a reasonable basis for seeking to verify the employee's stated beliefs will depend on the facts of a particular case.

EXAMPLE 31

Sincerity of Religious Belief Questioned

Bob, who had been a dues-paying member of the CDF union for fourteen years, had a work-related dispute with a union official and one week later asserted that union activities were contrary to his religion and that he could no longer pay union dues. The union doubted whether Bob's request was based on a sincerely held religious belief, given that it appeared to be precipitated by an unrelated dispute with the union, and he had not sought this accommodation in his prior fourteen years of employment. In this situation, the union can require him to provide additional information to support his assertion that he sincerely holds a religious conviction that precludes him from belonging to – or financially supporting – a union.^[225]

When an employer requests additional information, employees should provide information that addresses the employer's reasonable doubts. That information need not, however, take any specific form. For example, written materials or the employee's own first-hand explanation may be sufficient to alleviate the employer's doubts about the sincerity or religious nature of the employee's professed belief such that third-party verification is unnecessary. Further, since idiosyncratic beliefs can be sincerely held and religious, even when third-party verification is requested, it does not have to come from a clergy member or fellow congregant, but rather could be provided by others who are aware of the employee's religious practice or belief.^[226]

An employee who fails to cooperate with an employer's reasonable request for verification of the sincerity or religious nature of a professed belief risks losing any subsequent claim that the employer improperly denied an accommodation. By the same token, employers who unreasonably request unnecessary or excessive corroborating evidence risk being held liable for denying a reasonable accommodation request, and having their actions challenged as retaliatory or as part of a pattern of harassment.

EXAMPLE 32**Clarifying a Request**

Diane requests that her employer schedule her for “fewer hours” so that she can “attend church more frequently.” The employer denies the request because it is not clear what schedule Diane is requesting or whether the change is sought due to a religious belief or practice. While Diane’s request lacked sufficient detail for the employer to make a final decision, it was sufficient to constitute a religious accommodation request. Rather than denying the request outright, the employer should have obtained the information from Diane that it needed to make a decision. The employer could have inquired of Diane precisely what schedule change was sought and for what purpose, and how her current schedule conflicted with her religious practices or beliefs. Diane would then have had an obligation to provide sufficient information to permit her employer to make a reasonable assessment of whether her request was based on a sincerely held religious belief, the precise conflict that existed between her work schedule and church schedule, and whether granting an accommodation would pose an undue hardship on the employer’s business.

3. What is a “Reasonable” Accommodation?

Although an employer never has to provide an accommodation that would pose an undue hardship, *see infra* § 12-IV-B, it discharges its accommodation duty if it provides a “reasonable” accommodation. An adjustment offered by an employer is not a “reasonable” accommodation if it merely lessens rather than eliminates the conflict between religion and work, provided that eliminating the conflict would not impose an undue hardship.^[227] If all accommodations eliminating such a conflict would impose an undue hardship on an employer, the employer must reasonably accommodate the employee’s religious practice to the extent that it can without suffering an undue hardship, even though such an accommodation would be “partial” in nature.^[228] To qualify as a reasonable accommodation, an adjustment also must not discriminate against the employee or unnecessarily disadvantage the employee’s terms, conditions, or privileges of employment.^[229]

Where there is more than one reasonable accommodation that would not pose an undue hardship, the employer is not obliged to provide the accommodation preferred by the employee.^[230] However, an employer's proposed accommodation will not be "reasonable" if a more favorable accommodation is provided to other employees for non-religious purposes,^[231] or, for example, if it requires the employee to accept a reduction in pay rate or some other loss of a benefit or privilege of employment and there is an alternative accommodation that does not do so.^[232]

Ultimately, reasonableness is a fact-specific determination. "The reasonableness of an employer's attempt at accommodation cannot be determined in a vacuum. Instead, it must be determined on a case-by-case basis; what may be a reasonable accommodation for one employee may not be reasonable for another 'The term "reasonable accommodation" is a relative term and cannot be given a hard and fast meaning. Each case . . . necessarily depends upon its own facts and circumstances, and comes down to a determination of "reasonableness" under the unique circumstances of the individual employer-employee relationship.'"^[233]

EXAMPLE 33

Employer Violates Title VII if it Offers Only Partial Accommodation Where Full Accommodation Would Not Pose an Undue Hardship

Rachel, who worked as a ticket agent at a sports arena, asked not to be scheduled for any Friday night or Saturday shifts, to permit her to observe the Jewish Sabbath from sunset on Friday through sunset on Saturday. The arena wanted to give Rachel this time off only every other week. The arena's proposed adjustment does not fully eliminate the religious conflict and therefore cannot be deemed a reasonable accommodation in the absence of a showing that giving Rachel the requested time off every week poses an undue hardship for the arena. If the arena makes that showing, it must still accommodate Rachel's religious practice to the extent it can without suffering an undue hardship, which could include granting some, but not all, Friday evenings and/or Saturdays off.^[234]

EXAMPLE 34**Employer Not Obligated to Provide Employee's Preferred Accommodation**

Tina, a newly hired part-time store cashier whose sincerely held religious belief is that she should refrain from work on Sunday as part of her Sabbath observance, asked her supervisor never to schedule her to work on Sundays. Tina specifically asked to be scheduled to work Saturdays instead. In response, her employer offered to allow her to work on Thursdays, which she found inconvenient because she takes a college class on that day. Even if Tina preferred a different schedule, the employer is not required to grant Tina's preferred accommodation.^[235]

EXAMPLE 35**Accommodation by Transfer**

Yvonne, a member of the Pentecostal faith, was employed as a nurse at a hospital. When she was assigned to the Labor and Delivery Unit, she advised the nurse manager that her faith forbids her from participating directly or indirectly in ending a life, and that this proscription prevents her from assisting with abortions. She asked the hospital to accommodate her religious beliefs by allowing her to trade assignments with other nurses in the Labor and Delivery Unit as needed. The hospital concluded that, due to staffing cuts and risks to patients' safety, it could not accommodate Yvonne within the Labor and Delivery Unit because there were not enough staff members able and willing to trade with her. The hospital instead offered to permit Yvonne to transfer, without a reduction in pay or benefits, to a vacant nursing position in the Newborn Intensive Care Unit, which did not perform abortion procedures. As described below,^[236] an employee should be accommodated in his or her current position absent an undue hardship. Here, the hospital could not accommodate Yvonne in her current position due to staffing cuts and risks to patient safety, so the hospital's solution of a lateral transfer complies with Title VII.^[237] If the hospital is government run or receives federal funds, it could also

have obligations to accommodate Yvonne under federal laws protecting conscience rights of its health care employees.^[238]

Title VII is violated by an employer's failure to reasonably accommodate even if, to avoid adverse consequences, an employee continues to work after his or her accommodation request is denied. "[A]n employee who temporarily gives up his [or her] religious practice to submit to employment requirements [does not] waive[] his [or her] discrimination claim."^[239] Thus, the fact that an employee acquiesces to the employer's work rule, continuing to work without an accommodation after the employer has denied the request, should not defeat the employee's legal claim.^[240]

In addition, the obligation to provide reasonable accommodation absent undue hardship is a continuing obligation. Employers should be aware that an employee's religious beliefs and practices may evolve or change over time, and that this may result in requests for additional or different accommodations.^[241] Similarly, the employer has the right to discontinue a previously granted accommodation that is no longer utilized for religious purposes or subsequently poses an undue hardship.

B. Undue Hardship

An employer can refuse to provide a reasonable accommodation if it would pose an undue hardship. The Supreme Court has defined "undue hardship" for purposes of Title VII as imposing "more than a *de minimis* cost" on the operation of the employer's business.^[242] The concept of "more than *de minimis* cost" is discussed below in sub-section 2. Although the employer's showing of undue hardship under Title VII is easier than under the ADA, the burden of persuasion is still on the employer.^[243] If an employee's proposed accommodation would pose an undue hardship, the employer should explore alternative accommodations.

1. Case-by-Case Determination

The determination of whether a particular proposed accommodation imposes an undue hardship "must be made by considering the particular factual context of each case."^[244] Relevant factors may include the type of workplace, the nature of the employee's duties, the identifiable cost of the accommodation in relation to the size and operating costs of the employer, and the number of employees who will in fact need a particular accommodation.^[245] For example, an employer with multiple facilities might be better able than another employer to accommodate a Muslim

employee who seeks a transfer to a location with a nearby mosque that he can attend during his lunch break.

To prove undue hardship, the employer will need to demonstrate how much cost or disruption the employee's proposed accommodation would involve.^[246] An employer cannot rely on hypothetical hardship when faced with an employee's religious obligation that conflicts with scheduled work, but rather should rely on objective information.^[247] A mere assumption that many more people with the same religious practices as the individual being accommodated may also seek accommodation is not evidence of undue hardship.

2. More than “*De Minimis* Cost”

To establish undue hardship, the employer must demonstrate that the accommodation would require the employer “to bear more than a *de minimis* cost.”^[248] However, “[u]ndue hardship is something greater than hardship.”^[249] Factors to be considered include “the identifiable cost in relation to the size and operating costs of the employer, and the number of individuals who will in fact need a particular accommodation.”^[250] Generally, the payment of administrative costs necessary for an accommodation, such as costs associated with rearranging schedules and recording substitutions for payroll purposes, or infrequent or temporary payment of premium wages (e.g., overtime rates) while a more permanent accommodation is sought, will not constitute more than a *de minimis* cost, whereas the regular payment of premium wages or the hiring of additional employees to provide an accommodation will generally require more than *de minimis* cost to the employer.^[251]

Costs to be considered include not only direct monetary costs but also the burden on the conduct of the employer's business. For example, courts have found undue hardship where the accommodation diminishes efficiency in other jobs,^[252] infringes on other employees' job rights or benefits,^[253] impairs workplace safety,^[254] or causes coworkers to carry the accommodated employee's share of potentially hazardous or burdensome work.^[255] Whether the proposed accommodation conflicts with another law will also be considered.^[256]

EXAMPLE 36

Religious Need Can Be Accommodated

David wears long hair pursuant to his Native American religious beliefs. David applies for a job as a server at a restaurant which requires its male employees to wear their hair “short and neat,” in order to provide a certain image to its customers. When the restaurant manager informs David that if offered the position he will have to cut his hair, David explains that he keeps his hair long based on his religious beliefs and offers to wear it held up with a clip or under a hair net. The manager refuses this accommodation and denies David the position based on his long hair. Since the evidence indicated that David could have been accommodated, without undue hardship, by wearing his hair in a ponytail or held up with a clip, the employer will be liable for denial of reasonable accommodation and discriminatory failure to hire.

EXAMPLE 37

Safety Risk Poses Undue Hardship

Patricia alleges she was terminated from her job as a steel mill laborer because of her religion (Pentecostal) after she notified her supervisor that her faith prohibits her from wearing pants, as required by the mill’s dress code, and requested as an accommodation to be permitted to wear a skirt. Management contends that the dress code is essential to the safe and efficient operation of the mill and has evidence that it was imposed following several accidents in which skirts worn by employees were caught in the same type of mill machinery that Patricia operates. Because the evidence establishes that wearing pants is truly necessary for safety reasons, the accommodation requested by Patricia poses an undue hardship.^[257]

3. Seniority Systems and Collectively Bargained Rights

A proposed religious accommodation poses an undue hardship if it would deprive another employee of a job preference or other benefit guaranteed by a bona fide seniority system or collective bargaining agreement (CBA).^[258] Of course, the mere existence of a conflict between the requested accommodation and a seniority system or CBA does not relieve the employer of the duty to attempt reasonable

accommodation of its employees' religious practices; the question is whether an accommodation can be provided without violating the seniority system or CBA.^[259]

Allowing voluntary substitutes and swaps does not constitute an undue hardship to the extent the arrangements do not violate a bona fide seniority system or CBA.^[260]

Employer and employee arrangements regarding voluntary substitutes and swaps are discussed in more detail in section 12-IV-C-2.

EXAMPLE 38

Schedules Based on a Seniority System or Collectively Bargained Rights

Susan, an employee of Quick Corp., asks not to work on her Sabbath. Quick Corp. and its employees' union have negotiated a CBA which provides that weekend shifts will rotate evenly among employees. If Susan can find qualified coworkers voluntarily willing to swap shifts to accommodate her sincerely held religious beliefs, the employer could be found liable for denial of reasonable accommodation if it refuses to permit the swap to occur. The existence of the collectively bargained system for determining weekend shifts should not result in the denial of accommodation if a voluntary swap can be arranged by the employee without violating the system or otherwise posing an undue hardship. The result would be the same if Quick Corp. had a unilaterally imposed bona fide seniority system (rather than a CBA) pursuant to which weekend shifts are determined.

However, if other employees were unwilling to swap shifts or were otherwise harmed by not requiring Susan to work on the shift in question, or the employer would be subject to other operational costs that were more than *de minimis* by allowing Susan to swap shifts, then the employer can demonstrate undue hardship.^[261]

4. Coworker Complaints

Although infringing on coworkers' abilities to perform their duties^[262] or subjecting coworkers to a hostile work environment^[263] will generally constitute undue hardship, the general disgruntlement, resentment, or jealousy of coworkers will not.^[264] Undue hardship requires more than proof that some coworkers complained or

are offended by an unpopular religious belief or by alleged “special treatment” afforded to the employee requesting religious accommodation; a showing of undue hardship based on coworker interests generally requires evidence that the accommodation would actually infringe on the rights of coworkers or cause disruption of work.^[265] Applying this standard, it would be an undue hardship for an employer to accommodate religious expression that is unwelcome potential harassment based on race, color, sex, national origin, religion, age, disability, or genetic information, or based on its own internal anti-harassment policy, and it may take action consistent with its obligations under Title VII and the other EEO laws. See also §§ 12-III-C, *supra*, and 12-IV-C-6, *infra* (discussing complaints regarding proselytizing and other forms of religious expression).

5. Security Considerations

If a religious practice conflicts with a legally mandated federal, state, or local security requirement, an employer need not accommodate the practice because doing so would create an undue hardship. If a security requirement has been unilaterally imposed by the employer and is not required by law or regulation, courts will engage in a fact-specific inquiry to decide whether it would be an undue hardship to modify or eliminate the requirement to accommodate an employee who has a religious conflict.

EXAMPLE 39

Accommodation Implicating Security Concerns

Patrick is employed as a correctional officer at a state prison, and his brother William is employed as a grocery store manager. Both Patrick and William seek permission from their respective employers to wear a fez at work as an act of faith on a particular holy day as part of their religious expression. Both employers deny the request, citing a uniformly applied workplace policy prohibiting employees from wearing any type of head covering. The prison’s policy is based on security concerns, supported by evidence, that head coverings may be used to conceal drugs, weapons, or other contraband, and may spark internal violence among prisoners. The grocery store’s policy is based on a stated desire that all employees wear uniform clothing so that

they can be readily identified by customers. If both brothers file EEOC charges challenging the denials of their accommodation requests, the EEOC likely will not find reasonable cause in Patrick's case because the prison's denial of his request was based on legitimate, evidence-based security considerations posed by the particular religious garb sought to be worn. The EEOC likely will find cause in William's case because there is no indication it would pose an undue hardship for the grocery store to modify its policy with respect to his request.^[266]

EXAMPLE 40

Kirpan

Harvinder, a Sikh who works in a hospital, wears a small sheathed kirpan (religious article of faith resembling a knife) strapped and hidden underneath her clothing, as a symbol of her religious commitment to defend truth and moral values. When Harvinder's supervisor, Bill, learned about her kirpan from a coworker, he instructed Harvinder not to wear it at work because it violated the hospital policy against weapons in the workplace. Harvinder explained to Bill that her faith requires her to wear a kirpan in order to comply with the Sikh Code of Conduct and gave him literature explaining that the kirpan is a religious article of faith, not a weapon. She also showed him the kirpan, allowing him to see that it was no sharper than scissors, box cutters, cake knives, paper cutters, and other secular objects in the workplace. Nevertheless, Bill told her that she would be terminated if she continued to wear the kirpan at work. Absent evidence that allowing Harvinder to wear the kirpan would pose an undue hardship in the factual circumstances of this case, the hospital is liable for denial of accommodation.

C. Common Methods of Accommodation in the Workplace

Under Title VII, an employer or other covered entity may use a variety of methods to provide reasonable accommodations to its employees. The most common methods

are: (1) flexible scheduling; (2) voluntary substitutes or swaps of shifts and assignments; (3) lateral transfers or changes in job assignment; and (4) modifying workplace practices, policies, or procedures.

1. Scheduling Changes

An employer may be able to reasonably accommodate an employee by allowing flexible arrival and departure times, floating or optional holidays, flexible work breaks, use of lunch time in exchange for early departure, staggered work hours, and other means to enable an employee to make up time lost due to the observance of religious practices.^[267] However, EEOC's position is that it is insufficient merely to eliminate part of the conflict, unless eliminating the conflict in its entirety poses an undue hardship.^[268]

EXAMPLE 41

Break Schedules/Prayer at Work

Rashid, a janitor, tells his employer on his first day of work that he practices Islam and will need to pray at several prescribed times during the workday in order to adhere to his religious practice of praying at five times each day, for several minutes, with hand washing beforehand. The employer objects because its written policy allows one fifteen-minute break in the middle of each morning and afternoon. Rashid's requested change in break schedule will not exceed the 30 minutes of total break time otherwise allotted, nor will it affect his ability to perform his duties or otherwise cause an undue hardship for his employer. Thus, Rashid is entitled to accommodation.^[269]

EXAMPLE 42

Blanket Policies Prohibiting Time Off

A large employer operating a fleet of buses had a policy of refusing to accept driver applications unless the applicant agreed that he or she was available to be scheduled to work any shift, seven days a week.

This policy would violate Title VII if applied to discriminate against applicants who refrain from work on certain days for religious reasons, by failing to allow for the provision of religious accommodation absent undue hardship.^[270]

2. Voluntary Substitutes and Shift Swaps

The reasonable accommodation requirement can often be satisfied without undue hardship where a volunteer with substantially similar qualifications is available and willing to switch shifts, either for a single absence or multiple absences, including absences occurring over an extended period of time. “[T]he obligation to accommodate requires that employers and labor organizations facilitate the securing of a voluntary substitute with substantially similar qualifications. Some means of doing this which [covered entities] should consider are: to publicize policies regarding accommodation and voluntary substitution; to promote an atmosphere in which such substitutions are favorably regarded; to provide a central file, [physical or electronic] bulletin board or other means for matching voluntary substitutes with positions for which substitutes are needed.”^[271] The employer’s obligation is to make a good faith effort to allow voluntary substitutions and shift-swaps to accommodate a religious conflict.^[272] This does not require the employer itself to arrange a substitute or swap, but where it is difficult for employees to arrange shift substitutes or swaps on their own, the employer may have an obligation to do more to facilitate the search for volunteers.^[273] Likewise, if the employer is on notice that the employee’s religious beliefs preclude him not only from working on his Sabbath but also from inducing others to do so, reasonable accommodation requires more than merely permitting the employee to swap.^[274] An employer does not have to permit a substitute or swap if it would pose an undue hardship. As noted above, under the *de minimis* cost standard, if a swap or substitution would result in the employer having to pay premium wages (such as overtime pay), the frequency of the arrangement will be relevant to determining if it poses an undue hardship; “the Commission will presume that the infrequent payment of premium wages for a substitute or the payment of premium wages while a more permanent accommodation is being sought are costs which an employer can be required to bear as a means of providing a reasonable accommodation.”^[275]

If it does not pose an undue hardship, an employer must make an exception to its policy of requiring all employees, regardless of seniority, to work an “equal number

of weekend, holiday, and night shifts,” and instead permit voluntary shift swaps between qualified coworkers in order to accommodate a particular employee’s sincerely held religious belief that he should not work on his or her Sabbath. Of course, if allowing a swap or other accommodation would not provide the coverage the employer needs for its business operations or otherwise pose an undue hardship, the accommodation does not have to be granted.

3. Change of Job Tasks and Lateral Transfer

When an employee’s religious belief or practice conflicts with a particular task, appropriate accommodations may include relieving the employee of the task or transferring the employee to a different position or location that eliminates the conflict with the employee’s religion. Whether or not such accommodations pose an undue hardship will depend on factors such as the nature or importance of the duty at issue, the nature of the employer’s business, the availability of others to perform the function, the availability of other positions, and the applicability of a collective bargaining agreement or seniority system.

EXAMPLE 43

Restaurant Server Excused from Singing Happy Birthday

Kim, a server at a restaurant, informed her manager that she would not be able to join other waitresses in singing “Happy Birthday” to customers because she is a Jehovah’s Witness whose religious beliefs do not allow her to celebrate holidays, including birthdays. There were enough servers on duty at any given time to perform this singing without affecting service. The manager refused any accommodation. If Kim files a Title VII charge alleging denial of religious accommodation, the EEOC will find cause because the restaurant could have accommodated her with little or no expense or disruption.

EXAMPLE 44

Pharmacist Excused from Providing Contraceptives

Neil, a pharmacist, was hired by a large corporation that operates numerous large pharmacies at which more than one pharmacist is on duty during all hours of operation. Neil informed his employer that he refuses on religious grounds to participate in distributing contraceptives or answering any customer inquiries about contraceptives. The employer reasonably accommodated Neil by offering to allow Neil to signal discreetly to a coworker who would take over servicing any customer who telephoned, faxed, or came to the pharmacy regarding contraceptives.^[276]

EXAMPLE 45

Pharmacist Not Permitted to Turn Away Customers

In the above example, assume that instead of facilitating the assistance of such customers by a coworker, Neil leaves on hold indefinitely those who call on the phone about a contraceptive rather than transferring their calls, and walks away from in-store customers who seek to fill a contraceptive prescription rather than signaling a coworker. Neil refuses to signal another employee or inform the customer on the phone that he is placing them on a brief hold while he gets another employee. The employer is not required to accommodate Neil's request to remain in such a position yet avoid all situations where he might even briefly interact with customers who have requested contraceptives, or to accommodate a disruption of business operations. The employer may discipline or terminate Neil if he disrupts business operations.^[277]

The employee should generally be accommodated in his or her current position if doing so does not pose an undue hardship.^[278] For example, if a pharmacist who has a religious objection to dispensing contraceptives can be accommodated without undue hardship by allowing the pharmacist to signal a coworker to assist customers with such prescriptions, the employer should not choose instead to accommodate by transferring the pharmacist to a different position. If no such accommodation is possible, the employer needs to consider whether lateral transfer is a possible accommodation.^[279] The employer cannot transfer the pharmacist to a position that entails less pay, responsibility, or opportunity for

advancement unless a lateral transfer is unavailable or would otherwise pose an undue hardship.^[280]

EXAMPLE 46

Lateral Transfer Versus Transfer to a Lower-Paying Position

An electrical utility lineman requests accommodation of his Sabbath observance, but because the nature of his position requires being available to handle emergency problems at any time, there is no accommodation that would permit the lineman to remain in his position without posing an undue hardship. The employer can accommodate the lineman by offering a lateral transfer to another assignment at the same pay, if available. If, however, no job at the same pay is readily available, then the employer could satisfy its obligation to reasonably accommodate the lineman by offering to transfer him to a different job, even at lower pay, if one is available.^[281]

4. Modifying Workplace Practices, Policies and Procedures

An employer may have to make an exception to its policies, procedures, or practices in order to grant a religious accommodation.^[282]

a. Dress and Grooming Standards

When an employer has a dress or grooming policy that conflicts with an employee's religious beliefs or practices, the employee may ask for an exception to the policy as a reasonable accommodation.^[283] Religious dress may include clothes, head or face coverings, jewelry, or other items. Religious grooming practices may relate, for example, to shaving or hair length. Absent undue hardship, religious discrimination may be found where an employer fails to reasonably accommodate the employee's religious dress or grooming practices.^[284]

EXAMPLE 47

Facial Hair

Prakash, who works for CutX, a surgical instrument manufacturer, does not shave or trim his facial hair because of his Sikh religious observance. When he seeks a promotion to manage the division responsible for sterilizing the instruments, his employer tells him that, to work in that division, he must shave or trim his beard because otherwise his beard may contaminate the sterile field. When Prakash explains that he cannot trim his beard for religious reasons, the employer offers to allow Prakash to wear two face masks instead of trimming his beard. Prakash thinks that wearing two masks is unreasonable (for reasons unrelated to his religious practice) and files a Title VII charge. CutX will prevail because it offered a reasonable accommodation that would eliminate Prakash's religious conflict with the hygiene rule.

Some courts have concluded that it would pose an undue hardship if an employer was required to accommodate a religious dress or grooming practice that conflicts with the public image the employer wishes to convey to customers.^[285] While there may be circumstances in which allowing a particular exception to an employer's dress and grooming policy would pose an undue hardship, an employer's reliance on the broad rubric of "image" to deny a requested religious accommodation may in a given case be considered disparate treatment, including because it is tantamount to reliance on customer religious bias (so-called "customer preference") in violation of Title VII.^[286]

EXAMPLE 48

Religious Garb

Nasreen, a Muslim ticket agent for a commercial airline, wears a hijab (headscarf) to work at the airport ticket counter. After September 11, 2001, her manager objected, telling Nasreen that the customers might think she was sympathetic to terrorist hijackers. Nasreen explains to her manager that wearing the hijab is her religious practice and continues to wear it. She is terminated for wearing a hijab over her manager's objection. Customer fears or prejudices do not amount to undue hardship. As a result, the airline's refusal to accommodate her and its subsequent decision to terminate her violate Title VII. In addition, if the commercial airline had denied Nasreen the position

due to perceptions of customer preferences about religious attire, that would also be disparate treatment based on religion in violation of Title VII, because it would be the same as refusing to hire Nasreen because she is a Muslim. See *supra* § 12-II-B.^[287]

There may be limited situations in which the need for uniformity of appearance is so important that modifying the dress code would pose an undue hardship.^[288] This issue should be resolved on a case-by-case basis.

b. Use of Employer Facilities

If any employee needs to use a workplace facility as a reasonable accommodation, for example use of a quiet area for prayer during break time, the employer should accommodate the request under Title VII unless it would pose an undue hardship. If the employer allows employees to use the facilities at issue for non-religious activities not related to work, it may be difficult for the employer to demonstrate that allowing the facilities to be used in the same manner for religious activities is not a reasonable accommodation or poses an undue hardship.^[289]

EXAMPLE 49

Use of Employer Facilities

An employee whose assigned work area is a factory floor rather than an enclosed office asks his supervisor if he may use one of the company's unoccupied conference rooms to pray during a scheduled break time. The supervisor must grant this request if it would not pose an undue hardship. An undue hardship would exist, for example, if the only conference room is used for work meetings at that time. However, the supervisor is not required to provide the employee with his choice of the available locations and can meet the accommodation obligation by making any appropriate location available that would accommodate the employee's religious needs if this can be done absent undue hardship, for example by offering an unoccupied area of the work space rather than the conference room.

c. Tests and Other Selection Procedures

An employer has an obligation to reasonably accommodate an applicant when scheduling a test or administering other selection procedures, where the applicant has informed the employer of a sincerely held religious belief that conflicts with a pre-employment testing requirement, unless undue hardship would result.^[290] An employer may not permit an applicant's presumed or actual need for a religious accommodation to affect its decision whether or not to hire the applicant unless the employer can demonstrate that it cannot reasonably accommodate the applicant's religious observance or practice without undue hardship.^[291]

d. Objections to Providing Social Security Numbers or Complying with Employer Identification Procedures

Whether it poses an undue hardship for an employer to provide an alternative means of identification for matters such as government forms, building security, or timekeeping will depend on the facts. It will typically pose an undue hardship for an employer to accommodate an applicant's or employee's asserted religious belief against providing or using a social security number, or identification requirements imposed by another federal law.^[292] However, in cases where an alternative method of identification is feasible and does not pose an undue hardship, it may be required as a religious accommodation.^[293]

5. Excusing Union Dues or Agency Fees

Absent undue hardship, Title VII requires employers and unions to accommodate an employee who holds religious objections to joining or financially supporting a union.^[294] Such an employee can be accommodated, in many cases, by allowing the equivalent of her union dues (payments by union members) or agency fees (payments often required from non-union members in a unionized workplace) to be paid to a charity agreeable to the employee, the union, and the employer.^[295]

Whether a charity-substitute accommodation for payment of union dues would cause an undue hardship is an individualized determination based upon, among other things, the union's size, operational costs, and the number of individuals who need the accommodation.^[296]

If an employee's religious objection is not to joining or financially supporting the union, but rather to the union's support of certain political or social causes, the employee may be accommodated if it would not pose an undue hardship by, for example, reducing the amount owed, allowing the employee to donate to a charitable organization the full amount the employee owes or that portion that is

attributable to the union's support of the cause to which the employee has a religious objection, or diverting the amount owed to the national, state, or local union in the event one of those entities does not engage in support of the cause to which the employee has a religious objection.^[297]

6. Permitting Prayer, Proselytizing, and Other Forms of Religious Expression

Some employees may seek to display religious icons or messages at their workstations or use a particular religious phrase when greeting others. Others may seek to proselytize by engaging in one-on-one discussions regarding religious beliefs or distributing literature. Still others may seek to engage in prayer at their workstations or to use other areas of the workplace for either individual or group prayer, study, or meeting. In some of these situations, an employee might request accommodation in advance to permit such religious expression. In other situations, the employer will not learn of the situation or be called upon to consider any action unless it receives complaints about the religious expression from either other employees or customers. As noted in §§ 12-II-A-3 and 12-III-C of this document, prayer, proselytizing, and other forms of religious expression do not solely raise a religious accommodation issue but may also raise intentional discrimination or harassment issues.

To determine whether allowing or continuing to permit an employee to pray, proselytize, or engage in other forms of religiously oriented expression in the workplace would pose an undue hardship, employers should consider the potential disruption, if any, that will be posed by permitting the expression of religious belief.^[298] As explained below, relevant considerations may include the effect the religious expression has had, or can reasonably be expected to have, if permitted to continue, on coworkers, customers, or business operations.

a. Effect on Workplace Rights of Coworkers

Religious expression can create undue hardship if it disrupts the work of other employees or constitutes—or threatens to constitute—unlawful harassment. Conduct that is disruptive can still constitute an undue hardship, even if it does not rise to the level of unlawful harassment. Since an employer has a duty under Title VII to protect employees from harassment, it would be an undue hardship to accommodate expression that is harassing.^[299] As explained in § 12-III-A-2-b of this document, religious expression directed toward coworkers, made in coworkers'

presence, or that a coworker learns of, might constitute unlawful harassment in some situations, for example where it is facially abusive (i.e., demeans people of other religions) or where, even if not abusive, it persists even though it is clearly unwelcome. However, as with bias from customers, if coworkers' objections are not because the conduct is facially abusive or persistent but rather because of bias of coworkers against religious expression generally or that particular religious expression, it is unlikely that accommodating the religious expression would be an undue hardship. It is necessary to make a case-by-case determination regarding whether the effect on coworkers actually is an undue hardship. Mere subjective offense or disagreement with unpopular religious views or practices by coworkers is not sufficient to rise to the level of unlawful harassment. However, this does not require waiting until the unwelcome behavior becomes severe or pervasive.^[300] As with harassment on any basis, it is permitted and advisable for employers to take action to stop alleged harassment *before* it becomes severe or pervasive, because while isolated incidents of harassment generally do not violate federal law, a pattern of such incidents may be unlawful.^[301]

b. Effect on Customers

The determination of whether it is an undue hardship to allow employees to engage in religiously oriented expression toward customers is a fact-specific inquiry and will depend on the nature of the expression, the nature of the employer's business, and the extent of the impact on customer relations. For example, one court found that it was a reasonable accommodation to allow an employee to use the general religious greeting "Have a Blessed Day" with coworkers and with customers who had not objected, rather than using it with everyone, including a customer who objected.^[302] However, other courts have found undue hardship where religiously oriented expression was used in the context of a regular business interaction with a client.^[303] Whether or not the client objects, religiously oriented expression may create an undue hardship for an employer where the expression could be mistaken as the employer's message, particularly in the instance of government employers.^[304] Where the religiously oriented expression is not limited to use of a phrase or greeting, but rather is in the manner of individualized, specific proselytizing, an employer is far more likely to be able to demonstrate that it would constitute an undue hardship to accommodate an employee's religious expression, regardless of the length or nature of the business interaction.^[305]

EXAMPLE 50**Display of Religious Objects by an Employee**

Susan and Roger are members of the same church and are both employed at XYZ Corporation. Susan works as an architect in a private office on an upper floor, where she occasionally interacts with coworkers, but not with clients. Roger is a security guard stationed at a desk in the front lobby of the XYZ building through which all employees, clients, and other visitors must enter. At a recent service at Susan and Roger's church, the minister distributed posters with the message "Jesus Saves!" and encouraged parishioners to display the posters at their workplaces in order to "spread the word." Susan and Roger each display the poster on the wall above their respective workstations. XYZ orders both to remove the poster despite the fact that both explained that they felt a religious obligation to display it, and despite the fact that there have been no complaints from coworkers or clients.

Susan and Roger file charges alleging denial of religious accommodation. The employer will probably be unable to show that allowing Susan to display a religious message in her personal workspace posed an undue hardship, unless there was evidence of disruption to the business or the workplace which resulted. By contrast, because Roger sits at the lobby desk and the poster is the first thing that visitors see upon entering the building, it would appear to represent XYZ's views and would therefore likely be shown to pose an undue hardship.^[306]

EXAMPLE 51**Undue Hardship to Allow Employee to Discuss Religion with Clients**

Helen, an employee in a mental health facility that served a religiously and ethnically diverse clientele, frequently spoke with clients about religious issues and shared religious tracts with them as a way to help solve their problems, despite being instructed not to do so. After

clients complained, Helen's employer issued her a letter of reprimand stating that she should not promote her religious beliefs to clients and that she would be terminated if she persisted. Helen's belief in the need to evangelize to clients cannot be accommodated without undue hardship. The employer has the right to control speech that threatens to impede provision of effective and efficient services. Clients, especially in a mental health setting, may not understand that the religious message represents Helen's beliefs rather than the facility's view of the most beneficial treatment for the patient.^[307]

7. Employer-Sponsored Programs

Some employers have integrated their own religious beliefs or practices into the workplace, and they are entitled to do so.^[308] However, if an employer holds religious services or programs or includes prayer in business meetings, Title VII requires that the employer accommodate an employee who asks to be excused for religious reasons, including non-belief, absent a showing of undue hardship.^[309] Excusing an employee from religious services normally does not create an undue hardship because it does not cost the employer anything and does not disrupt business operations or other workers.^[310]

EXAMPLE 52

Prayer at Meetings

Michael's employer requires that the mandatory weekly staff meeting begin with a religious prayer. Michael objects to participating because he believes it conflicts with his own sincerely held religious beliefs. He asks his supervisor to allow him to arrive at the meeting after the prayer. The supervisor must accommodate Michael's religious belief by either granting his request or offering an alternative accommodation that would remove the conflict between Michael's religious belief and the staff meeting prayer, even if other employees of Michael's religion do not object to being present for the prayer.^[311] The outcome would be the same if Michael sought the accommodation based on his lack of religious belief.

EXAMPLE 53**Employer Holiday Decorations**

Each December, the president of XYZ corporation directs that several wreaths be placed around the office building and a tree be displayed in the lobby. Several employees complain that to accommodate their non-Christian religious beliefs, the employer should take down the wreaths and tree, or alternatively should add holiday decorations associated with other religions. Title VII does not require that XYZ corporation remove the wreaths and tree or add holiday decorations associated with other religions.^[312] The result under Title VII on these facts would be the same whether in a private or government workplace.^[313]

Similarly, an employer is required, absent undue hardship, to excuse an employee from compulsory personal or professional development training or participation in an initiative or celebration where it conflicts with the employee's sincerely held religious beliefs, observances, or practices.^[314] There may be cases, however, where an employer can show that it would pose an undue hardship to provide an alternative training or to excuse an employee from any part of a particular training, even if the employee asserts it is contrary to his religious beliefs to attend (e.g., where the training provides information on how to perform the job, on how to comply with equal employment opportunity obligations, or on other workplace policies, procedures, or applicable legal requirements).

EXAMPLE 54**Religious Objection to Training Program – Employee Must Be Excused**

As part of its effort to promote employee health and productivity, the new president of a company institutes weekly mandatory on-site meditation classes led by a local spiritualist. Angelina explains to her supervisor that the meditation conflicts with her sincerely held religious beliefs and asks to be excused from participating. Because it would not pose an undue hardship, the company must accommodate Angelina's religious belief by excusing her from the weekly meditation

classes, even if the company and other employees believe that this form of meditation does not conflict with any religious beliefs.

EXAMPLE 55

Religious Objection to Training Program – Employee Need Not Be Excused

Employer XYZ holds an annual training for employees on a variety of personnel matters, including compliance with EEO laws and also XYZ's own internal anti-discrimination policy, which includes a prohibition on sexual orientation discrimination. Lucille asks to be excused from the portion of the training on sexual orientation discrimination because she believes that it "promotes the acceptance of homosexuality," which she sincerely believes is immoral and sinful based on her religion. The training does not tell employees to value different sexual orientations but simply discusses and reinforces laws and conduct rules requiring employees not to discriminate against or harass other employees based on sexual orientation and to treat one another professionally. Because an employer needs to make sure that its employees know about and comply with such laws and workplace rules, it would be an undue hardship for XYZ to excuse Lucille from the training.^[315]

• NOTE TO EEOC INVESTIGATORS •

While not all of the following issues will be in dispute in every charge alleging denial of religious accommodation, if CP alleges that R failed to accommodate CP's religious beliefs, observances, or practices, the investigator should generally follow this line of inquiry, considering these steps:

⇒ Ascertain the nature of the belief, observance, or practice that CP claims R has failed to accommodate (e.g., dress, grooming, holy day observance, etc.) and what accommodation was sought and needed (e.g., exception to dress code, schedule change, leave, etc.).

- ⇒ If disputed by R, determine what evidence R relies on to support its position that CP's beliefs are not "religious" in nature.
- ⇒ If disputed by R, determine what evidence R relies on to support its position that CP does not "sincerely hold" the particular religious belief, observance, or practice at issue.
- ⇒ Ascertain whether R was aware of the need for a religious accommodation, i.e., whether CP informed R that an accommodation was needed and that it was for religious reasons, whether R knew of the need for a religious accommodation through other means, or whether R believed CP needed an accommodation (regardless of whether that belief was accurate). The investigator should seek evidence of when, where, how, and to whom any such notice was given, and the names of any witnesses to the notification, or, absent such notice, evidence regarding whether R believed CP would require accommodation.
- ⇒ If R claims that it was not aware of CP's need for an accommodation, the investigator should attempt to resolve any discrepancies between R's contention and CP's allegation by gathering additional available evidence corroborating or refuting CP's and R's contentions.
- ⇒ Determine R's response, if any, to any notification of the need for an accommodation or any belief that an accommodation may be required. Was an accommodation offered, and if so, what? The investigator should obtain R's documentary evidence of all attempts to accommodate CP, if any attempts were made.
- ⇒ The investigator should seek a specific and complete explanation from R as to the facts on which it relied in making a determination regarding whether to accommodate CP (e.g., why R concluded CP did not have a sincerely held religious belief or practice, what accommodations, if any, R offered, why it chose to offer or not offer an accommodation, or why R concluded that accommodation would have posed an undue hardship in terms of cost, disruption, effect on coworkers, or any other reason). For example, in the event R is a union and the accommodation claim relates to payment of agency fees or union dues, the investigator should obtain any relevant information regarding how the particular union at issue may have handled payment by this religious objector in order to provide accommodation.
- ⇒ If R asserts that it did not accommodate CP's request because it would have posed an undue hardship, obtain all available evidence regarding whether and what kind of a hardship would in fact have been posed, i.e., whether the alleged burden would have been more than *de minimis*. If R's undue hardship defense

is based on cost, ascertain the cost of the accommodation in relation to R's size, nature of business operations, operating costs, and the impact, if any, of similar accommodations already being provided to other employees. If R's undue hardship defense is based on a factor other than cost (i.e., disruption, production or staffing levels, security, or other factor), similarly ascertain the impact of the accommodation with respect to R's particular workplace and business.

- ⇒ When there is more than one method of accommodation available that would not cause undue hardship, the investigator should evaluate whether the accommodation offered is reasonable by examining: (1) whether any alternative accommodation that was available was reasonable; (2) whether R considered any alternatives for accommodation; (3) the alternative(s) for accommodation, if any, that R actually offered to CP; (4) whether the alternative(s) the employer offered eliminated the conflict; and (5) whether the alternative(s) the employer offered adversely affected CP's terms, conditions, or privileges of employment or employment opportunities, as compared to other available accommodations (e.g., a loss in pay).^[316]
- ⇒ If R asserts CP failed to cooperate with R in reaching an accommodation, obtain any available evidence regarding the relevant communications between R and CP, including any evidence documenting CP's refusal of any offer of reasonable accommodation.
- ⇒ If it appears, or if CP claims, that R based an adverse action (e.g., refusal to hire) in part on its belief that CP would need a religious accommodation, obtain any available evidence bearing on the employer's motivations for the action.

• Employer Best Practices •

Reasonable Accommodation - Generally.

- Employers should inform employees and applicants that they will make reasonable efforts to accommodate religious practices.
- Employers should train managers and supervisors on how to recognize religious accommodation requests from employees.
- Employers should consider developing internal procedures for processing religious accommodation requests. Where the employer relies on a staffing

firm or other entity for any of its staffing needs, the employer and the staffing entity should coordinate in advance how they will handle accommodating applicants' or employees' religious beliefs or practices, consistent with these best practices.

- Employers should individually assess each request and avoid assumptions or stereotypes about what constitutes a religious belief or practice or what type of accommodation is appropriate.
- Employers and employees should confer fully and promptly to the extent needed to share any necessary information about the employee's religious needs and the available accommodation options.
- An employer is not required to provide an employee's preferred accommodation if there is more than one reasonable alternative. An employer should, however, consider the employee's proposed method of accommodation, and if it is denied, explain to the employee why his proposed accommodation is not being granted.
- Managers and supervisors should be trained to consider alternative available accommodations if the particular accommodation requested would pose an undue hardship.
- When faced with a request for a religious accommodation which cannot be promptly implemented, an employer should consider offering alternative methods of accommodation on a temporary basis, while a permanent accommodation is being explored. In this situation, an employer should also keep the employee apprised of the status of the employer's efforts to implement a permanent accommodation.

Undue Hardship – Generally

- The undue hardship standard refers to the legal requirement. Employers should be flexible in evaluating whether or not an accommodation is feasible, in light of that legal requirement. As with all aspects of employee relations, employers are free to go beyond the requirements of the law.
- An employer should not assume that an accommodation will conflict with the terms of a seniority system or collective bargaining agreement (CBA) without first checking if there are any exceptions for religious accommodation or other

avenues to allow an accommodation consistent with the seniority system or CBA.

- An employer should not automatically reject a request for religious accommodation just because the accommodation would interfere with the existing seniority system or terms of a CBA. Although an employer may not upset coworkers' settled expectations, an employer is free to seek a voluntary modification to a CBA in order to accommodate an employee's religious needs.
- Employers should train managers that, if the requested accommodation would violate the CBA or seniority system, they should confer with the employee to determine if an alternative accommodation is available.
- Employers should ensure that managers are aware that reasonable accommodation may require making exceptions to policies or procedures that are not part of a CBA or seniority system, where it would not infringe on other employees' legitimate expectations.

Schedule Changes

- Employers should work with employees who need an adjustment to their work schedules to accommodate their religious practices.
- Notwithstanding that the legal standard for undue hardship is "more than a *de minimis* cost," employers may choose voluntarily to incur whatever additional operational or financial costs they deem appropriate to accommodate an employee's religious need for scheduling flexibility.
- Employers should consider adopting flexible leave and scheduling policies and procedures that will often allow employees to meet their religious and other personal needs. Such policies can reduce individual requests for exceptions. For example, some employers have policies allowing alternative work schedules or a certain number of "floating" holidays for each employee. While such policies may not cover every eventuality and some individual accommodations may still be needed, the number of such individual accommodations may be substantially reduced.

Voluntary Substitutes or Swaps

- Employers should facilitate and encourage voluntary substitutions and swaps with employees of substantially similar qualifications by publicizing policies permitting such arrangements, promoting an atmosphere in which substitutes are favorably regarded, and providing a central file, bulletin board, group e-mail, or other means to help an employee with a religious conflict find a volunteer to substitute or swap.

Change of Job Assignments and Lateral Transfers

- An employer should consider a lateral transfer when no accommodation which would keep the employee in his or her position is possible absent undue hardship. However, an employer should only resort to transfer, whether lateral or otherwise, after fully exploring accommodations that would permit the employee to remain in his or her position.
- Where a lateral transfer is unavailable, an employer should not assume that an employee would not be interested in a lower-paying position if that position would enable the employee to abide by his or her religious beliefs. If there is no accommodation available that would permit the employee to remain in his or her current position or an equivalent, the employer should offer the next best available position as an accommodation and permit the employee to decide whether or not to take it.

Modifying Workplace Practices, Policies, and Procedures

- Employers should make efforts to accommodate an employee's religious practice of wearing a beard or religious garb such as a yarmulke, hijab, long skirts (as opposed to pants), or turban.
- Managers and employees should be trained not to engage in stereotyping based on religious dress and grooming practices and should not assume that atypical dress will create an undue hardship.
- Employers should be flexible and creative regarding work schedules, work duties, and selection procedures to the extent practicable.
- Employers should be sensitive to the risk of unintentionally pressuring or coercing employees to attend social gatherings if an employee has indicated a religious objection to attending.

Permitting Prayer, Proselytizing, and Other Forms of Religious Expression

- Employers should train managers to gauge the actual disruption posed by religious expression in the workplace, rather than merely speculating that disruption may result. Employers should also train managers to identify alternatives that might be offered to avoid actual disruption (e.g., designating an unused or private location in the workplace where a prayer session, study, or meeting can occur if it is disrupting other workers in a different location).
- Employers should incorporate a discussion of religious expression, and the need for all employees to treat each other professionally, regardless of actual or perceived religious or lack of religious beliefs, into any anti-harassment training provided to managers and employees.

• Employee Best Practices •

- Employees should advise their supervisors or managers of the nature of the conflict between their religious needs and the work rules.
- Employees should provide enough information to enable the employer to understand what accommodation is needed, and why it is necessitated by a religious observance, practice, or belief.
- Employees who seek to proselytize in the workplace should cease doing so with respect to any individual who indicates that the communications are unwelcome.

12-V RELATED FORMS OF DISCRIMINATION**A. National Origin, Race, and Color**

Title VII's prohibition against religious discrimination may overlap with Title VII's prohibitions against discrimination based on national origin, race, and color. Where a given religion is strongly associated – or perceived to be associated – with a certain national origin, the same facts may state a claim of both religious and national origin discrimination.^[317] All four bases might be implicated where, for example, coworkers target a dark-skinned Muslim employee from Saudi Arabia for harassment because of his color, religion, national origin, and/or race.^[318]

B. Retaliation

Title VII prohibits retaliation by an employer, employment agency, or labor organization because an individual has engaged in protected activity.^[319] Protected activity consists of opposing a practice the employee reasonably believes is made unlawful by one of the employment discrimination statutes or filing a charge, testifying, assisting, or participating in any manner in an investigation, proceeding, or hearing under Title VII.^[320] EEOC has taken the position that requesting a religious accommodation is a protected activity under this provision of Title VII.^[321] Retaliation in this context means taking an action against the employee because of her protected activity that “well might have dissuaded a reasonable worker from making or supporting a charge of discrimination.”^[322]

EXAMPLE 56

Retaliation for Requesting Accommodation

Jenny requests that she be excused from daily employer-sponsored Christian prayer meetings because she is an atheist. Her supervisor insists that she attend, but she persists in her request that she should be excused and explains that requiring her to attend is offensive to her religious beliefs. She takes her request to human resources and informs them that requiring her to attend these prayer meetings is offensive to her religious beliefs. Despite her supervisor’s objections, the human resources department instructs the supervisor that in the circumstances no undue hardship is posed and he must grant the request. Motivated by reprisal, her supervisor shortly thereafter gives her an unjustified poor performance rating and denies her requests to attend training that is approved for similarly situated employees. This retaliation violates Title VII.

• Employer Best Practices •

Retaliation

- Employers can reduce the risk of retaliation claims by training managers and supervisors to be aware of their anti-retaliation obligations under Title VII, including specific actions that may constitute retaliation.
- Employers can help reduce the risk of retaliation claims by carefully and timely recording the accurate business reasons for disciplinary or performance-related actions and sharing these reasons with the employee.

Addendum on Executive Order Compliance

Guidance Procedures

Executive Order 13891

The definition of “guidance” in Executive Order 13891 encompasses this interpretive guidance. See Exec. Order No. 13891, 84 Fed. Reg. 155235, 155235 (defining “guidance document”); Memorandum from Dominic J. Mancini, Acting Administrator, Office of Information and Regulatory Affairs, Office of Management and Budget, to Regulatory Policy Officers at Executive Departments and Agencies and Managing Directors of Certain Agencies and Commissions (Oct. 31, 2019), <https://www.whitehouse.gov/wp-content/uploads/2019/10/M-20-02-Guidance-Memo.pdf> (<https://www.whitehouse.gov/wp-content/uploads/2019/10/M-20-02-Guidance-Memo.pdf>) (explaining the exclusions under E.O. 13891).

Because the Commission is issuing this document as interpretive guidance, within the recognized constraints of its authority, the Commission concludes that the guidance procedures under Executive Order 13891, as codified in EEOC regulations at 29 CFR 1695.01-.10, apply. Accordingly, the Commission states that:

The contents of this document do not have the force and effect of law and are not meant to bind the public in any way. Any final document is intended only to provide clarity to the public regarding existing requirements under the law or agency policies.

The EEOC and the Office of Management and Budget (OMB) have determined that the guidance raises novel legal or policy issues arising out of legal mandates, the

President's priorities, or the principles set forth in Executive Order 12866. In consequence, it is "significant guidance" within the meaning of Section 2(c) of Executive Order 13891. Pursuant to Section 4(a)(iii)(D) of Executive Order 13891, an agency submitting a significant guidance document to OIRA for review should demonstrate how the guidance document complies with Executive Orders 12866, 13563, 13609,^[323] 13771, and 13777.

Executive Order 12866

The EEOC has coordinated issuance of the guidance with OMB. Pursuant to Section 3(f) of Executive Order 12866, the EEOC and OMB have determined that the guidance will not have an annual effect on the economy of \$100 million or more. It will not adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities. It will not create a serious inconsistency or otherwise interfere with an action taken or planned by another agency, nor will they materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof. It will, however, raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in Executive Order 12866. In consequence, it is "significant regulatory action" within the meaning of section 3(f) of Executive Order 12866.

Executive Order 13563

The guidance will maximize net benefits and reduce the burden on the public by clarifying the legal standards applicable to religious discrimination claims, presenting typical scenarios in which religious discrimination may arise, and providing guidance to employers on how to balance the needs of individuals in a diverse religious climate. The guidance is not being issued because of any retrospective review.

Executive Orders 13771

The guidance will reduce the burden on the public by clarifying the legal standards the EEOC will apply to religious discrimination claims. The guidance will be an Executive Order 13771 deregulatory action.

Executive Orders 13777

Providing clear, accurate guidance that is up to date with current law is part of the Commission's regulatory reform agenda. Therefore, this guidance is being issued as part of the Commission's regulatory reform agenda.

Congressional Review Act

Pursuant to 29 C.F.R. § 1695.6(e), the Commission will submit this significant guidance document to Congress under the procedures described in 5 U.S.C. § 801. This guidance is not a "major rule" as defined in 5 U.S.C. § 804(2).

Addendum Pursuant to 29 C.F.R. §1695.6(c) on Major Comments on Proposed Compliance Manual on Religious Discrimination and EEOC Responses

The EEOC received 71 unique comments^[324] from individuals, organizations, and members of Congress on the proposed Compliance Manual on Religious Discrimination, which was posted for public input on www.regulations.gov (<http://www.regulations.gov>) on November 17, 2020. A number of these comments were submitted on behalf of multiple organizations or officeholders, including one on behalf of 51 organizations and another on behalf of 44 organizations. The major comments and the Commission's responses to those comments are summarized below.

Process

Comment: Numerous organizational and Congressional commenters asserted that there was insufficient opportunity for stakeholder consultation and inadequate time allotted for Commissioner and public input. These commenters requested that the Commission withdraw rather than finalize the proposed guidance. Several commenters also expressed concerns with listening sessions that the General Counsel held and the commenters felt that they undermined the comment period.

Response: The Commission engaged in an internal process and inter-agency consultation before issuing the proposal, and then provided a

standard 30-day public input period. This is the first significant guidance that the Commission has issued under the regulations found at 29 CFR 1695.01-.10, which call for a public comment period and other procedural measures. In 2008, the public was not given an opportunity to comment on a proposed draft of the guidance. The comment period yielded many detailed comments from a wide range of stakeholders representing many differing perspectives. Moreover, issuance of both the proposal and of the final guidance was subject to review and clearance by the Office of Management and Budget. Many public commenters noted that the update is needed and timely. Regarding the General Counsel's listening sessions, these sessions were not organized to receive comments on the proposed guidance. Instead, they were an opportunity for the General Counsel to hear organizations' perspectives on the Commission's enforcement efforts. The General Counsel did not seek comments on the proposed guidance and instead encouraged participants to submit comments through the formal process, if they were interested. Furthermore, the listening sessions in no way prevented the public from having the opportunity to comment.

Definition of Religion

Comment: Some commenters expressed concern that the draft did not make sufficiently clear that Title VII protects against discrimination based on a lack of religious faith.

Response: The Commission has made additions to reference repeatedly that discrimination based on a lack of religious faith is prohibited.

Religious Organization Exemption

Comment: Various commenters took issue with the draft's statement that it was an "open question" whether a for-profit corporation can constitute a "religious corporation" within the meaning of section 702(a) of Title VII, 42 U.S.C. § 2000e(1) (a).

Response: The final guidance has deleted this language. Instead, the final guidance observes that although courts have historically relied on for-profit status to indicate that an entity is not a "religious corporation" under § 702(a), the plain text of the statute does not reference for-profit

and nonprofit status, and that it is possible courts may be more receptive to finding a for-profit corporation can qualify given language from the Supreme Court's decision in *Hobby Lobby*.

Comment: Many organizational and Congressional commenters asked for clarification or revision of the proposal's interpretation of the scope of the statutory exemption permitting employment of individuals "of a particular religion" by religious corporations under § 702(a) or religious educational institutions under § 703(e)(2). Some commenters asked the Commission to state that religious organizations are barred from discrimination based on race, color, sex, national origin, or other bases, even if motivated by a religious belief. By contrast, others asked for greater clarity that religious organizations are shielded from such claims by the statutory permission to hire individuals "of a particular religion." Additionally, some commenters discussed how the Commission should proceed if a respondent entity invokes the religious organization exception.

Response: The final guidance clearly states that religious organizations are subject to the Title VII prohibitions against discrimination on the basis of race, color, sex, national origin (as well as the anti-discrimination provisions of the ADEA, ADA, and GINA), and related retaliation, but are permitted to assert the statutory exemption as an affirmative defense.

The guidance further notes that "[c]ourts have held that the religious organization's assertion that the challenged employment decision was made on the basis of religion is subject to a pretext inquiry, where the employee has the burden to prove pretext." The guidance discusses a case where the court found if the religious organization presented "'convincing evidence' that the challenged employment practice resulted from discrimination on the basis of religion," then the religious organization exemption "deprives the EEOC of jurisdiction to investigate further to determine whether the religious discrimination was a pretext for some other form of discrimination."

Ministerial Exception

Comment: Some commenters objected to the nature or extent of the Commission's treatment of the ministerial exception. Others discussed the draft's handling of

procedural matters relating to adjudication of the ministerial exception when asserted as a defense.

Response: The final guidance has streamlined the discussion of the ministerial exception and has clarified how the Commission will procedurally address assertions of the defense.

Interaction of Title VII with the First Amendment and the Religious Freedom Restoration Act (RFRA)

Comment: Numerous commenters asked the Commission to delete or modify references to RFRA as a potential defense to Title VII enforcement by the government. Some noted the holdings in particular Title VII decisions addressing RFRA defenses, and cited RFRA's legislative history stating it was not intended to modify Title VII.

Response: The final guidance refines treatment of the cited authorities in this section, including explanations of the outcome in cases in which RFRA was raised as a defense to EEO enforcement.

Comment: The National Federation of Independent Business recommended insertion of language guiding EEOC staff to confer with the EEOC Office of Legal Counsel, which may as needed consult with the Department of Justice's Office of Legal Counsel, when matters raise the interaction of the First Amendment or RFRA with statutes enforced by the EEOC.

Response: The final guidance includes this type of instruction to EEOC staff.

Employment Decisions

Comment: The Sikh Coalition requested that an example in this section be revised to illustrate a claim of unlawful segregation of those who wear religious garb, and also requested various descriptions of ritual practices in this and other sections to improve accuracy and reduce rather than reinforce bias or stereotypes.

Response: The final guidance incorporates these recommended changes.

Harassment

Comment: Numerous commenters asked the Commission to clarify and further emphasize that consensual non-harassing conversations about religious topics are not potential harassment of coworkers.

Response: The final guidance includes additional statements and examples illustrating instances of non-harassing, non-disruptive religious expression.

Comment: Some commenters recommended that the Commission address whether or when employee statements on private social media may implicate the EEO laws with respect to discrimination, including harassment, either by or against religious employees.

Response: The final guidance adds additional authority to the discussion of social media and harassment.

Interaction of Harassment and Accommodation of Religious Expression

Comment: With respect to balancing harassment and accommodation obligations, numerous commenters asked the Commission to make clear that employers are permitted to, and should, take remedial action once on notice of unwelcome potential harassment on any basis, even if the harassing conduct is not yet severe or pervasive.

Response: The final guidance includes additional language explicitly reiterating an employer's rights and responsibilities under Title VII with respect to coworker complaints about unwelcome harassing conduct.

Reasonable Accommodation and Undue Hardship

Comment: Various commenters addressed the Commission's statement in the draft that a denial of religious accommodation absent undue hardship is actionable even if there was not an additional, independent adverse employment action taken against the employee. Some commenters agreed with the Commission's position and others opposed it.

Response: The final guidance maintains the Commission's position, which is also articulated in the existing 2008 document, and has been the subject of past and current litigation brought by the Commission on

behalf of applicants and employees who were unlawfully denied religious accommodation. Requiring an employee to work without religious accommodation where a work rule conflicts with his religious beliefs necessarily alters the terms and conditions of his employment for the worse.

Comment: Numerous commenters expressed concerns that the Commission's citation to laws enforced by the U.S. Department of Health and Human Services regarding rights of those with objections to participating in certain health care duties could be misleading with respect to the requirements under either those laws or Title VII.

Response: The final guidance includes a clear statement that the Commission is referencing these laws for informational purposes and is not opining on any of their requirements or whether they would require additional burdens on employers beyond Title VII's analysis for reasonable accommodation.

Comment: Commenters offered a range of perspectives on the Supreme Court's 1977 holding that the Title VII undue hardship defense permits an employer to deny any religious accommodation that would impose more than a *de minimis* burden on the operation of the employer's business. Some commenters believed the Commission's inclusion of a citation to Justice Alito's concurring opinion in the denial of certiorari in *Patterson v. Walgreen Co.*, 140 S. Ct. 685 (2020), expressing that the Court should reconsider this definition, was potentially confusing or misleading.

Response: The final guidance deletes this citation to ensure clarity regarding the current legal standard.

[1] This document uses examples that refer to practices and beliefs of various religions. These examples are intended to clarify the legal principles for which they are used and do not purport to represent the religious beliefs or practices of all members of the cited religions. Unless otherwise noted, cases are cited in this document for their holdings under Title VII of the Civil Rights Act of 1964 (Title VII). In some instances, links to non-EEOC internet sites are provided for the reader's convenience in obtaining additional information; EEOC assumes no responsibility for their content and does not endorse their organizations or guarantee the

accuracy of these sites. Use of the term “employee” in this document should be presumed to include an applicant and, as appropriate, a former employee.

[2] See 42 U.S.C. § 2000e(k) (Title VII’s prohibition against sex discrimination applies to discrimination “because of or on the basis of pregnancy, childbirth, or related medical conditions.”); *Bostock v. Clayton Cnty.*, 140 S. Ct. 1731, 1737 (2020) (holding that Title VII’s prohibition of discrimination based on sex, 42 U.S.C. § 2000e-2(a), includes a prohibition of discrimination because of sexual orientation or transgender status).

[3] 42 U.S.C. § 2000e-2(a)(1), (2).

[4] 42 U.S.C. § 2000e(j).

[5] *Trans World Airlines, Inc. v. Hardison*, 432 U.S. 63, 84 (1977).

[6] Compare *Hardison*, 432 U.S. at 84 (interpreting Title VII “undue hardship” standard), with 42 U.S.C. § 12111(10)(A) (defining ADA “undue hardship” standard). Note: Various state and local laws extend beyond Title VII in terms of the protected bases covered, the discrimination prohibited, the accommodation required, and the legal standards and defenses that apply.

[7] See, e.g., *Cooper v. Gen. Dynamics, Convair Aerospace Div.*, 533 F.2d 163, 168 (5th Cir. 1976) (stating “all forms and aspects of religion, however eccentric, are protected”).

[8] This common formulation derives from the seminal Supreme Court decisions interpreting the conscience exemption in the Military Selective Service Act, 50 U.S.C. § 3806(j). See, e.g., *Redmond v. GAF Corp.*, 574 F.2d 897, 901 n.12 (7th Cir. 1978) (“We believe the proper test to be applied to the determination of what is ‘religious’ under § 2000e(j) can be derived from the Supreme Court decisions in *Welsh v. United States*, 398 U.S. 333 (1970), and *United States v. Seeger*, 380 U.S. 163 (1969), i.e., (1) is the ‘belief’ for which protection is sought ‘religious’ in person’s own scheme of things, and (2) is it ‘sincerely held.’” (quoting those decisions)); *Fallon v. Mercy Cath. Med. Ctr.*, 877 F.3d 487, 490-91 (3d Cir. 2017) (applying same test to Title VII claim of religious discrimination); *Davis v. Fort Bend Cnty.*, 765 F.3d 480, 485 (5th Cir. 2014) (same); *Adeyeye v. Heartland Sweeteners, LLC*, 721 F.3d 444, 448 (7th Cir. 2013) (same); *EEOC v. Union Independiente de la Autoridad de Acueductos*, 279 F.3d 49, 56 (1st Cir. 2002) (same); see also, e.g., EEOC Guidelines on Discrimination Because of

Religion, 29 C.F.R. § 1605.1 (stating that EEOC has “consistently applied” this standard to Title VII).

[9] *Fallon*, 877 F.3d at 491 (quoting *Welsh*, 398 U.S. at 340 (quoting *Seeger*, 380 U.S. at 176)).

[10] See, e.g., *Noyes v. Kelly Servs.*, 488 F.3d 1163, 1168 (9th Cir. 2007) (addressing “non-adherence or reverse religious discrimination claim”); *Reed v. Great Lakes Cos.*, 330 F.3d 931, 933-34 (7th Cir. 2003) (“[F]or these purposes, . . . ‘religion’ includes antipathy to religion. And so an atheist . . . cannot be fired because his employer dislikes atheists.”); *Shapolia v. Los Alamos Nat’l Lab’y*, 992 F.2d 1033, 1037 (10th Cir. 1993) (plaintiff claimed he was fired “because he did not hold the same religious beliefs as his supervisors”); *Young v. Sw. Sav. & Loan Ass’n*, 509 F.2d 140 (5th Cir. 1975) (finding Title VII violated by requiring atheist employee to attend prayer portion of business meeting).

[11] *Masterpiece Cakeshop, Ltd. v. Colo. Civil Rights Comm’n*, 138 S. Ct. 1719, 1731-32 (2018) (holding that a state administrative agency’s consideration of baker’s First Amendment free exercise claim opposing alleged violation of public accommodations nondiscrimination law “violated the State’s duty under the First Amendment not to base laws or regulations on hostility to a religion or religious viewpoint” and apply laws “in a manner that is neutral toward religion”); *Epperson v. Ark.*, 393 U.S. 97, 103-04 (1968) (“Government in our democracy, state and national, must be neutral in matters of religious theory, doctrine, and practice. It may not be hostile to any religion or to the advocacy of no religion; and it may not aid, foster, or promote one religion or religious theory against another or even against the militant opposite. The First Amendment mandates governmental neutrality between religion and religion, and between religion and nonreligion.”); see also *Bd. of Educ. v. Grumet*, 512 U.S. 687, 714 (1994) (O’Connor, J., concurring) (“We have time and again held that the government generally may not treat people differently based on the God or gods they worship, or do not worship.”).

[12] In fiscal year 2019, EEOC received 2,725 religious discrimination charges, accounting for 3.7% of all charges filed with the Commission that year. In fiscal year 1997, EEOC received 1,709 religious discrimination charges, accounting for 2.1% of all charges filed with the Commission that year. Statistics regarding the number of religious discrimination charges filed with the Commission and dispositions can be found at <https://www.eeoc.gov/statistics/religion-based-charges-charges-filed->

eeoc-fy-1997-fy-2019 (<https://www.eeoc.gov/statistics/religion-based-charges-charges-filed-eeoc-fy-1997-fy-2019>).

[13] In general, the principles discussed in this Section apply to Title VII claims against private employers as well as to federal, state, and local public sector employers, unless otherwise noted. See 42 U.S.C. §§ 2000e(a)-(b), 2000e-16(a) *et seq.* See, e.g., *infra* § 12-I-C-3 (“Additional Interaction of Title VII with the First Amendment and the Religious Freedom Restoration Act (RFRA)”). Claims under various state or local laws may be analyzed under different standards. Investigators should contact the Office of Legal Counsel if questions arise about how to appropriately analyze charges brought against government entities.

[14] 42 U.S.C. § 2000e-2. To determine whether an entity is covered by Title VII, see EEOC, Compliance Manual: Threshold Issues (2000), <https://www.eeoc.gov/laws/guidance/section-2-threshold-issues> [hereinafter Threshold Issues]. Although this document concerns Title VII, employers and employees should note that there may be state and local laws in their jurisdiction prohibiting religious discrimination in employment, some of which may be parallel to Title VII and some of which may afford broader coverage.

[15] See, e.g., *EEOC v. Abercrombie & Fitch Stores, Inc.*, 731 F.3d 1106, 1120 (10th Cir. 2013) (“A religious accommodation claim is distinct from a disparate treatment claim.” (quoting EEOC, Compliance Manual: Religious Discrimination § 12-IV (2008)), discussing case law describing disparate treatment and reasonable accommodation as different theories of discrimination), *rev’d and remanded*, 575 U.S. 768, 135 S. Ct. 2028 (2015).

[16] *Abercrombie & Fitch Stores, Inc.*, 135 S. Ct. at 2031-32.

[17] *Id.* at 2032-33. Since the *Abercrombie* decision was issued, some lower courts have nevertheless continued to characterize denial of accommodation as a distinct cause of action.

[18] 42 U.S.C. § 2000e(j); see *Redmond v. GAF Corp.*, 574 F.2d 897, 900 (7th Cir. 1978) (observing that “the very words of the statute . . . leave little room for such a limited interpretation”; “to restrict the act to those practices which are mandated or prohibited by a tenet of the religion, would involve the court in determining not only what are the tenets of a particular religion, which by itself perhaps would not be beyond the province of the court, but would frequently require the courts to decide whether a particular practice is or is not required by the tenets of the religion,” a

determination that would be “irreconcilable with the warning issued by the Supreme Court” that “[i]t is no business of courts to say . . . what is a religious practice or activity” (quoting *Fowler v. Rhode Island*, 345 U.S. 67, 70 (1953)); see also *Emp’t Div., Dep’t of Hum. Res. v. Smith*, 494 U.S. 872, 887 (1990) (explaining in Free Exercise Clause case that “[r]epeatedly and in many different contexts, we have warned that courts must not presume to determine the place of a particular belief in a religion or the plausibility of a religious claim”). However, as discussed in this section, Title VII does not cover all beliefs; for example, social, political, or economic philosophies, and mere personal preferences, are not “religious” beliefs within the meaning of the statute.

[19] See *Thomas v. Rev. Bd.*, 450 U.S. 707, 714 (1981) (ruling that “religious beliefs need not be acceptable, logical, consistent, or comprehensible to others in order to merit First Amendment protection”); see also *Church of Lukumi Babalu Aye, Inc. v. City of Hialeah*, 508 U.S. 520, 531 (1993) (holding that although animal sacrifice may seem “abhorrent” to some, Santeria belief is religious in nature and is protected by the First Amendment); *Toronka v. Cont’l Airlines*, 649 F. Supp. 2d 608, 612 (S.D. Tex. 2009) (holding in Title VII case that a moral and ethical belief in the power of dreams that is based on religious convictions and traditions of African descent is a religious belief, and that this determination does not turn on veracity but rather is based on a theory of “man’s nature or his place in the Universe,” even if considered by others to be “nonsensical” (quoting *Brown v. Dade Christian Schs., Inc.*, 556 F.2d 310, 324 (5th Cir. 1977) (Roney, J., dissenting))); *United States v. Meyers*, 906 F. Supp. 1494, 1499 (D. Wyo. 1995) (relying on First Amendment jurisprudence to observe in Religious Freedom Restoration Act case that “one man’s religion will always be another man’s heresy”).

[20] *Welsh v. United States*, 398 U.S. 333, 339 (1970) (interpreting what is now the Military Selective Service Act, 50 U.S.C. § 3806(j)); see also *Thomas*, 450 U.S. at 716 (“[I]t is not within the judicial function and judicial competence to inquire whether the petitioner or [another practitioner] . . . more correctly perceived the commands of their common faith. Courts are not arbiters of scriptural interpretation.”) (First Amendment).

[21] *United States v. Seeger*, 380 U.S. 163, 166, 176 (1965). Although *Seeger* arose under what is now the Military Selective Service Act, 50 U.S.C. § 3806(j), the EEOC has “consistently applied this standard” to Title VII, see *Commission Guidelines*, 29 C.F.R. § 1605.1. The courts have as well. See *supra* note 8.

[22] *Thomas*, 450 U.S. at 714 (“The determination of what is a ‘religious’ belief or practice is more often than not a difficult and delicate task. . . . However, the resolution of that question is not to turn upon a judicial perception of the particular belief or practice in question; religious beliefs need not be acceptable, logical, consistent, or comprehensible to others in order to merit First Amendment protection.”); *Burwell v. Hobby Lobby Stores, Inc.*, 573 U.S. 682, 725 (2014) (“[I]t is not for us to say that the line [employee] drew [between work that was consistent with religious beliefs and work that was morally objectionable] was an unreasonable one.” (quoting *Thomas*, 450 U.S. at 715)).

[23] *Commission Guidelines*, 29 C.F.R. § 1605.1 (“The fact that no religious group espouses such beliefs or the fact that the religious group to which the individual professes to belong may not accept such belief will not determine whether the belief is a religious belief of the employee or prospective employee.”); *Welsh*, 398 U.S. at 343 (finding that petitioner’s beliefs were religious in nature although the church to which he belonged did not teach those beliefs) (Military Selective Service Act); *accord Africa v. Pennsylvania*, 662 F.2d 1025, 1032-33 (3d Cir. 1981) (First Amendment); *Bushouse v. Local Union 2209, United Auto., Aerospace & Agric. Implement Workers of Am.*, 164 F. Supp. 2d 1066, 1076 n.15 (N.D. Ind. 2001) (“Title VII’s intention is to provide protection and accommodation for a broad spectrum of religious practices and belief not merely those beliefs based upon organized or recognized teachings of a particular sect.”).

[24] *Commission Guidelines*, 29 C.F.R. § 1605.1 (“This standard was developed in [*Seeger*] and [*Welsh*]. The Commission has consistently applied this standard in its decisions.”); see *Torcaso v. Watkins*, 367 U.S. 488, 489-90 (1961) (ruling that government may not favor theism over pantheism or atheism) (First and Fourteenth Amendments); *Welsh*, 398 U.S. at 339-340 (reiterating that a belief in God or divine beings is not necessary to qualify as a religion; nontheistic beliefs can be religious within the meaning of the statute as long as they “occupy in the life of that individual ‘a place parallel to that filled by . . . God’ in traditionally religious persons.”).

[25] *United States v. Meyers*, 906 F. Supp. 1494, 1499 (D. Wyo. 1995) (observing that the threshold for establishing the religious nature of beliefs is low; under the First Amendment, “if there is any doubt about whether a particular set of beliefs constitutes a religion, the Court will err on the side of freedom and find that the beliefs are a religion . . . [because the country’s] founders were animated in large part by a desire for religious liberty”), *aff’d*, 95 F.3d 1475, 1482-83 (10th Cir. 1996);

see also *Emp't Div., Dep't of Human Res. of Or. v. Smith*, 494 U.S. 887, 887 (1990) (explaining in Free Exercise Clause case that “[r]epeatedly and in many different contexts, we have warned that courts must not presume to determine the place of a particular belief in a religion or the plausibility of a religious claim”).

[26] *Meyers*, 906 F. Supp. at 1502 (ruling that religions address “ultimate ideas,” i.e., “fundamental questions about life, purpose, and death,” and that single-faceted worship of marijuana was not a religion for First Amendment purposes), *aff'd*, 95 F.3d at 1483. “Thus, a genuinely held belief that involves matters of the afterlife, spirituality, or the soul, among other possibilities, qualifies as religion under Title VII.” *Adeyeye v. Heartland Sweeteners, LLC*, 721 F.3d 444, 448 (7th Cir. 2013).

[27] *Fallon v. Mercy Catholic Med. Ctr. of Se. Pa.*, 877 F.3d 487, 491 (3d Cir. 2017) (quoting *Africa*, 662 F.2d at 1032). Although “religion” is often marked by external manifestations such as ceremonies, rituals or clergy, such manifestations are not required for a belief to be “religious.” See, e.g., *Malnak v. Yogi*, 592 F.2d 197, 209-10 (3d Cir. 1979).

[28] See *Fallon*, 877 F.3d at 492 (employee’s objection to flu vaccine did not qualify as a religious belief protected by Title VII because his beliefs that “one should not harm their own body and . . . that the flu vaccine may do more harm than good” did not “address fundamental and ultimate questions having to do with deep and imponderable matters” and were not “comprehensive in nature”). Similarly, EEOC and courts have found that the Ku Klux Klan is not a religion within the meaning of Title VII because its philosophy has a narrow, temporal, and political character. See Commission Decision No. 79-06, CCH EEOC Decisions ¶ 6737 (1983); *Bellamy v. Mason’s Stores, Inc.*, 368 F. Supp. 1025, 1026 (E.D. Va. 1973), *aff’d*, 508 F.2d 504 (4th Cir. 1974); *Slater v. King Soopers*, 809 F. Supp. 809, 810 (D. Colo. 1992) (dismissing religious discrimination claim by a member of the Ku Klux Klan who allegedly was fired for participating in a Hitler rally because the Ku Klux Klan is “political and social in nature” and is not a religion for Title VII purposes); see also *Brown v. Pena*, 441 F. Supp. 1382, 1385 (S.D. Fla. 1977) (holding that plaintiff’s belief that eating cat food contributes to his well-being is a personal preference and not a religion). In a related context, the Supreme Court has held that, unlike religious beliefs, philosophical and personal beliefs “do[] not rise to the demands of the Religion Clauses.” *Wisconsin v. Yoder*, 406 U.S. 205, 216 (1972). When evaluating whether the belief qualifies as religious, courts should consider whether the belief is merely focused on an “isolated moral teaching” or rather is part of a “comprehensive system of beliefs about fundamental or ultimate matters.” *Fallon*, 877 F.3d at 492.

[29] *Fallon*, 877 F.3d at 492. See also *Shelton v. Univ. of Med. & Dentistry of N.J.*, 223 F.3d 220, 225 (3d Cir. 2000) (addressing merits of Title VII religious accommodation claim based on plaintiff's refusal to participate in medical procedures that terminate a pregnancy); cf. *Gadling-Cole v. W. Chester Univ.*, 868 F. Supp. 2d 390, 396-97 (E.D. Pa. 2012) (emphasizing that Title VII religious discrimination claims have been held cognizable as to topics that "overlap both the religious and political spectrum, such as abortion, so long as the claims are based on a plaintiff's bona fide religious belief").

[30] See *Yoder*, 406 U.S. at 216 (explaining that "if the Amish asserted their [free exercise] claims [against a compulsory education law] because of their subjective evaluation and rejection of the contemporary secular values accepted by the majority, much as Thoreau rejected the social values of his time and isolated himself at Walden Pond, their claims would not rest on a religious basis").

[31] See *Davis v. Fort Bend Cnty.*, 765 F.3d 480, 485, 486-87 (5th Cir. 2014) (holding that whether a practice is religious turns not on the nature of the activity itself, but rather whether the plaintiff "sincerely believed it to be religious in her own scheme of things," and finding the lower court erred in characterizing plaintiff's attendance at service and event breaking ground for a new church and feeding community as "a personal commitment, not religious conviction"); *Redmond v. GAF Corp.*, 574 F.2d 897, 901 (7th Cir. 1978) (finding the employer liable for failing to accommodate employee's participation in Saturday Bible classes pursuant to a sincerely held religious belief given that he was appointed to be lifetime leader of his church Bible study class many years earlier, time of meeting was scheduled by church elders, and employee felt that his participation was at dictate of his elders and constituted a "religious obligation"); see also *Dachman v. Shalala*, 9 F. App'x 186, 191-93 (4th Cir. 2003) (ruling that plaintiff's accommodation request to be home by time of Sabbath observance was covered by Title VII, but time off sought for tasks that could be performed at another time, such as purchasing ritual foods, cooking, and cleaning in preparation for the observance, was a personal preference that the employer was not required to accommodate); *Jiglov v. Hotel Peabody, GP*, 719 F. Supp. 2d 918, 929-30 (W.D. Tenn. 2010) (holding that a scheduling accommodation request could be covered by Title VII where employee's religious dictates for observance of Russian Orthodox Easter included not only attendance at church service but also a priest's blessing of the family meal, the sharing of the meal, and prayer with family members); *Duran v. Select Med. Corp.*, No. 08-cv-2328-JPM-tmp, 2010 WL 11493117, at *5-6 (W.D. Tenn. Mar. 19, 2010) (holding that a scheduling accommodation

request to be able to attend Christmas Mass was covered by Title VII, but not the family meal and gift exchange that followed).

[32] *Cf. Spies v. Voinovich*, 173 F.3d 398, 406-07 (6th Cir. 1999) (ruling there was no obligation to accommodate a vegan diet that an individual conceded was unrelated to his Zen Buddhist religious beliefs); *LaFevers v. Saffle*, 936 F.2d 1117 (10th Cir. 1991) (holding that although not all Seventh-day Adventists are vegetarian, an individual adherent's genuine religious belief in such a dietary practice warrants constitutional protection under the First Amendment).

[33] *Compare Fallon*, 877 F.3d at 492-93 (recognizing that anti-vaccination beliefs such as those held by Christian Scientists can be part of a "broader religious faith" and therefore subject to Title VII religious accommodation in some circumstances, but concluding that plaintiff's beliefs did not qualify as religious because he "simply worries about the health effects of the flu vaccine, disbelieves the scientifically accepted view that it is harmless to most people, and wishes to avoid this vaccine."), *with Chenzira v. Cincinnati Child's Hosp. Med. Ctr.*, No. 1:11-CV-00917, 2012 WL 6721098, at *4 (S.D. Ohio Dec. 27, 2012) (holding that Title VII could cover a request to be excused from hospital mandatory vaccination policy due to vegan opposition to a vaccine that was animal-tested or contains animal byproducts if plaintiff "subscribe[d] to veganism with a sincerity equating that of traditional religious views," noting her citation to essays about veganism and to Biblical excerpts).

[34] *Davis*, 765 F.3d at 486 (quoting *Tagore v. United States*, 735 F.3d 324, 328 (5th Cir. 2013)); *see also Adeyeye v. Heartland Sweeteners, LLC*, 721 F.3d 444, 452 (7th Cir. 2013) (emphasizing that Title VII has a "broad and intentionally hands-off definition of religion").

[35] *See Dettmer v. Landon*, 799 F.2d 929, 932 (4th Cir. 1986) (rejecting argument that witchcraft was a "conglomeration" of "various aspects of the occult" rather than a religion, because religious beliefs need not be "acceptable, logical, consistent or comprehensible to others" to be protected under the First Amendment); *Wash. Ethical Soc'y v. Dist. of Columbia*, 249 F.2d 127, 128 (D.C. Cir. 1957) (holding that ethical society qualifies as a "religious corporation or society" under District of Columbia Tax Statute, and its building is entitled to tax exemption; belief in a Supreme Being or supernatural power is not essential to qualify for tax exemption accorded to "religious corporations," "churches," or "religious societies"). *Compare EEOC v. United Health Programs of Am., Inc.*, 213 F. Supp. 3d 377, 402 (E.D.N.Y. 2016) (holding, where plaintiff alleged harassment or denial of religious accommodation,

that employer's use of conflict resolution program known as "Onionhead" or "Harnessing Happiness" was a "religion" within the meaning of Title VII, since program's system of beliefs and practices was more than intellectual and involved ultimate concerns signifying religiosity, including chants, prayers, and mentions of God, transcendence, and souls), *with Cavanaugh v. Bartelt*, 178 F. Supp. 3d 819, 829-30 (D. Neb. 2016) (ruling that allegation one is a "Pastafarian," a believer in the divine "Flying Spaghetti Monster" who practices the religion of "FSMism," was not a religion within the meaning of Religious Land Use and Institutionalized Persons Act, 42 U.S.C. § 1983, or Constitution, but instead "a parody, intended to advance an argument about science, the evolution of life, and the place of religion in public education"), *aff'd*, No. 16-2105 (8th Cir. Sept. 7, 2016).

[36] See *EEOC v. Red Robin Gourmet Burgers, Inc.*, No. C04-1291JLR, 2005 WL 2090677, at *3 (W.D. Wash. Aug. 29, 2005) (denying employer's motion for summary judgment on religious accommodation claim arising from employee's refusal to cover his Kemetic religious tattoos to comply with employer's dress code).

[37] See *Fallon*, 877 F.3d at 491.

[38] *Dockery v. Maryville Acad.*, 379 F. Supp. 3d 704, 718 n.18 (N.D. Ill. 2019) (ruling that "while the 'validity' of a religious belief cannot be questioned, 'the threshold question of sincerity . . . must be resolved in every case'" (quoting *United States v. Seeger*, 380 U.S. 163, 185 (1965))).

([https://1.next.westlaw.com/Link/Document/FullText?findType=Y&serNum=1965125037&pubNum=0000780&originatingDoc=I9cf9b910544c11e987fd8441446aa305&refType=RP&fi=co_pp_sp_780_185&originatio nContext=document&transitionType=DocumentItem&contextData=\(sc.Search\)#co_pp_sp_780_185](https://1.next.westlaw.com/Link/Document/FullText?findType=Y&serNum=1965125037&pubNum=0000780&originatingDoc=I9cf9b910544c11e987fd8441446aa305&refType=RP&fi=co_pp_sp_780_185&originatio nContext=document&transitionType=DocumentItem&contextData=(sc.Search)#co_pp_sp_780_185)).

[39] See *Dediol v. Best Chevrolet, Inc.*, 655 F.3d 435, 443 (5th Cir. 2011) (reciting prima facie case for harassment because of religion without reference to inquiry into sincerity of religious belief); *Dixon v. Hallmark Cos.*, 627 F.3d 849 (11th Cir. 2010) (analyzing sincerity of religious belief only with respect to failure-to-accommodate claim, not with respect to discriminatory termination claim).

[40] Cf. *Moussazadeh v. Tx. Dep't of Crim. Just.*, 703 F.3d 781, 790 (5th Cir. 2012) (case arising under Religious Land Use and Institutionalized Persons Act (RLUIPA)).

[41] *Adeyeye v. Heartland Sweeteners, LLC*, 721 F.3d 444, 452 (7th Cir. 2013) (holding that inquiring into sincerity is limited to determining if the asserted belief or

practice is in fact the employee's own religious belief; it should not entail considering any matters such as whether employee had a true conversion experience or whether the practices are embedded in his cultural and family upbringing); see also *Thomas v. Rev. Bd. of Ind. Emp. Sec. Div.*, 450 U.S. 707, 716 (1981) ("Particularly in this sensitive area [where employee had quit job producing armaments citing religious objections and claimed that state's denial of unemployment compensation violated the First Amendment], it is not within the judicial function and judicial competence to inquire whether the petitioner or his fellow worker [another Jehovah's Witness who was willing to take the same job] more correctly perceived the commands of their common faith. Courts are not arbiters of scriptural interpretation.").

[42] *Davis v. Ft. Bend Cnty.*, 765 F.3d 480, 486 (5th Cir. 2014) (quoting *Tagore v. United States*, 735 F.3d 324, 328 (5th Cir. 2013)).

[43] *Grayson v. Schuler*, 666 F.3d 450, 454-55 (7th Cir. 2012) (finding in RLUIPA case that Nazirite prisoner's asserted belief in not cutting his hair was sincerely held).

[44] *EEOC v. Union Independiente De La Autoridad De Acueductos*, 279 F.3d 49, 57 (1st Cir. 2002).

[45] See, e.g., *id.* (holding that evidence the employee had violated a number of tenets of his professed Seventh Day Adventist faith was sufficient to create a triable issue of fact for jury); *Hansard v. Johns-Manville Prods. Corp.*, No. 1902, 1973 WL 129, at *2 (E.D. Tex. Feb. 16, 1973) (employee's contention that he objected to Sunday work for religious reasons was undermined by his very recent history of Sunday work); see also *Hussein v. Waldorf-Astoria*, 134 F. Supp. 2d 591, 596 (S.D.N.Y. 2001) (employer had a good faith basis to doubt sincerity of employee's professed religious need to wear a beard because he had not worn a beard at any time in his fourteen years of employment, had never mentioned his religious beliefs to anyone at the hotel, and simply showed up for work one night and asked for an on-the-spot exception to the no-beard policy), *aff'd*, 2002 WL 390437 (2d Cir. Mar. 13, 2002).

[46] See, e.g., *Brown v. Gen. Motors Corp.*, 601 F.2d 956, 960 (8th Cir. 1979) ("[42 U.S.C.] § 2000e-2(a)(1) does not require an employer to reasonably accommodate the purely personal preferences of its employees" and thus would not have required the employer in this case to bear the costs of "excusing vast numbers of employees who wish to have Friday night off for secular reasons"); *Dachman v. Shalala*, 9 F. App'x 186, 192 (4th Cir. 2001) (holding that employer not required to accommodate Jewish employee's desire to leave work earlier on Friday afternoon to

pick up Challah bread instead of doing it on Thursday evening; “Title VII does not protect secular preferences” (quoting *Tiano v. Dillard Dep't Stores, Inc.*, 139 F.3d 679, 682 (9th Cir. 1998))).

[47] See, e.g., *Union Independiente*, 279 F.3d at 57 (fact that employee initially “objected only to certain membership requirements” and “voiced his opposition to any form of union membership after UIA agreed to accommodate him with respect to each practice he had identified” gave rise to jury issue on sincerity).

[48] See, e.g., *EEOC v. Ilona of Hungary, Inc.*, 108 F.3d 1569, 1575 (7th Cir. 1997) (en banc) (finding that Jewish employee proved her request for leave to observe Yom Kippur was based on a sincerely held religious belief even though she had never in her prior eight-year tenure sought leave from work for a religious observance, and conceded that she generally was not a very religious person, where the evidence showed that certain events in her life, including the birth of her son and the death of her father, had strengthened her religious beliefs over the years); *Cooper v. Oak Rubber Co.*, 15 F.3d 1375 (6th Cir. 1994) (holding that employee held sincere religious belief against working on Saturdays, despite having worked the Friday night shift at plant for approximately seven months after her baptism, where seventeen months intervened before employee was next required to work on Saturday and employee’s undisputed testimony was that her faith and commitment to her religion grew during this time); *Cunningham v. City of Shreveport*, 407 F. Supp. 3d 595, 609-10 (W.D. La. 2019) (holding that disputed material facts precluded summary judgment on sincerity where employee who previously grew beard during vacations and extended weekends asserted new religious adherence prompted wearing beard full-time); *EEOC v. IBP, Inc.*, 824 F. Supp. 147, 151 (C.D. Ill. 1993) (holding that Seventh-day Adventist employee’s previous absence of faith and subsequent loss of faith did not prove that his religious beliefs were insincere at the time that he refused to work on the Sabbath); see also *Union Independiente*, 279 F.3d at 57 & n.8 (noting the fact that the alleged conflict between plaintiff’s beliefs and union membership kept changing might call into question the sincerity of the beliefs or “might simply reflect an evolution in plaintiff’s religious views toward a more steadfast opposition to union membership”).

[49] See *EEOC v. Alamo Rent-A-Car, LLC*, 432 F. Supp. 2d 1006, 1012 (D. Ariz. 2006) (finding that it was Muslim employee’s sincerely held religious observance to wear headscarf during Ramadan, even though she did not wear it the rest of the year).

[50] See *EEOC v. Triangle Catering, LLC*, No. 5:15-CV-00016-FL, 2017 WL 818261, at *9 (E.D.N.C. Mar. 1, 2017) (holding that reasonable factfinder could conclude employee had sincerely held religious belief in wearing religious garb if it credited his explanation for not having worn it to job interview for fear of hiring discrimination).

[51] See *Commission Guidelines*, 29 C.F.R. § 1605.1; *Adeyeye v. Heartland Sweeteners, LLC*, 721 F.3d 444, 452-54 (7th Cir. 2013) (holding that employee presented sufficient evidence to show that his request to attend his father's funeral in Nigeria to perform specific rites, traditions, and customs “was borne from his own personally and sincerely held religious beliefs” because “participating in the rites and traditions identified by his father is a necessary part of [the employee’s] religious observance” even though employee’s religious practices “were not identical to the religious practices his family observes in Nigeria”).

[52] *Anderson v. U.S.F. Logistics (IMC), Inc.*, 274 F.3d 470, 475 (7th Cir. 2001) (finding that employee’s belief that she needed to use the phrase “Have a Blessed Day” was a religious practice covered by Title VII even though using the phrase was not a requirement of her religion); *Heller v. EBB Auto Co.*, 8 F.3d 1433, 1438 (9th Cir. 1993); see also *Adeyeye*, 721 F.3d at 452 (“It is not within our province to evaluate whether particular religious practices or observances are necessarily orthodox or even mandated by an organized religious hierarchy.”).

[53] Title 42 U.S.C. § 2000e-2(a) applies to employers with fifteen or more employees. See 42 U.S.C. § 2000e(b). Section 2000e-2(b) applies to employment agencies, stating it is unlawful for employment agencies to “fail or refuse to refer for employment, or otherwise to discriminate against, any individual because of his . . . religion . . . or to classify or refer for employment any individual on the basis of his . . . religion” Section 2000e-2(c) applies to unions, stating it is unlawful for unions to “(1) to exclude or expel from membership, or otherwise to discriminate against, any individual because of his . . . religion . . . ; (2) to limit, segregate or classify its membership or applicants . . . or to refuse to refer for employment any individual . . . because of such individual’s . . . religion . . . ; or (3) to cause or attempt to cause an employer to discriminate . . . in violation of this section.”

[54] See Threshold Issues, *supra* note 14.

[55] See, e.g., *EEOC v. Union Independiente De La Autoridad De Acueductos*, 279 F.3d 49 (1st Cir. 2002); *Bushouse v. Local Union 2209*, 164 F. Supp. 2d 1066 (N.D. Ind. 2001). For further discussion see *infra* §§ 12-II, 12-III, and 12-IV, including 12-IV-C-5.

[56] See *Goodman v. Lukens Steel Co.*, 482 U.S. 656, 668-69 (1987) (holding that unions violated “§ 703(c)(1) [of Title VII, which] makes it an unlawful practice for a Union to ‘exclude or to expel from its membership, or otherwise to discriminate against, any individual’” when they “ignored [racial] discrimination claims . . . , knowing that the employer was discriminating in violation of the contract”); *Rainey v. Town of Warren*, 80 F. Supp. 2d 5, 17 (D.R.I. 2000) (“It is axiomatic that a union’s failure to adequately represent union members in the face of employer discrimination may subject the union to liability under either Title VII or its duty of fair representation.”). To the extent it has been held that a union cannot be held liable where it knowingly acquiesces in discrimination, the EEOC disagrees. See *EEOC v. Pipefitters Ass’n Local Union 597*, 334 F.3d 656 (7th Cir. 2003); see also *Burton v. Freescale Semiconductor, Inc.*, 789 F.3d 222, 229 (5th Cir. 2015) (“A staffing agency is liable for the discriminatory conduct of its joint-employer client if it participates in the discrimination, or if it knows or should have known of the client’s discrimination and fails to take corrective measures within its control.”).

[57] Section 702(a) of Title VII, 42 U.S.C. § 2000e-1(a), provides:

[Title VII] shall not apply to . . . a religious corporation, association, educational institution, or society with respect to the employment of individuals of a particular religion to perform work connected with the carrying on by such corporation, association, educational institution, or society of its activities.

Section 703(e)(2) of Title VII, 42 U.S.C. § 2000e-2(e)(2) provides:

[I]t shall not be an unlawful employment practice for a school, college, university, or educational institution or institution of learning to hire and employ employees of a particular religion if such school, college, university, or other educational institution or institution of learning is, in whole or in substantial part, owned, supported, controlled, or managed by a particular religion or by a particular religious corporation, association, or society, or if the curriculum of such school, college, university, or other educational institution or institution of learning is directed toward the propagation of a particular religion.

The Americans with Disabilities Act (ADA) also provides religious entities with two defenses to claims of discrimination that arise under Title I, the ADA’s employment provisions. The first provides that “[t]his subchapter shall not prohibit a religious corporation, association, educational institution, or society from giving preference

in employment to individuals of a particular religion to perform work connected with the carrying on by such [entity] of its activities.” 42 U.S.C. § 12113(d)(1). The second provides that “[u]nder this subchapter, a religious organization may require that all applicants and employees conform to the religious tenets of such organization.” 42 U.S.C. § 12113(d)(2).

[58] *Hall v. Baptist Mem’l Health Care Corp.*, 215 F.3d 618, 624 (6th Cir. 2000); see also *Garcia v. Salvation Army*, 918 F.3d 997, 1003 (9th Cir. 2019) (“In applying the [religious organization exemption], we determine whether an institution’s ‘purpose and character are primarily religious’ by weighing ‘[a]ll significant religious and secular characteristics.’” (quoting *EEOC v. Townley Eng’g & Mfg. Co.*, 859 F.2d 610, 618 (9th Cir. 1988)) (second alteration in original)); *LeBoon v. Lancaster Jewish Cmty. Ctr.*, 503 F.3d 217, 226 (3d Cir. 2007) (applying similar “primarily religious” standard); *Killinger v. Samford Univ.*, 113 F.3d 196, 198-99 (11th Cir. 1997) (looking at specific facts to determine whether university was “religious” or “secular”).

[59] *LeBoon*, 503 F.3d at 226; but see *Spencer v. World Vision, Inc.*, 633 F.3d 723, 730-33 (O’Scannlain, J. concurring) (expressing concern that “several of the *LeBoon* factors could be constitutionally troublesome if applied to this case”).

[60] In *Hall*, 215 F.3d at 624-25, the Sixth Circuit, looking to “all the facts,” found that a college of health sciences was a Title VII religious organization because it was an affiliated institution of a church-affiliated hospital, it had a direct relationship with the Baptist church, and the college atmosphere was permeated with religious overtones. In *Spencer v. World Vision, Inc.*, 633 F.3d 723, 724 (9th Cir. 2011) (per curiam), the Ninth Circuit held that an entity is “eligible” for the exemption, at least, if the entity (1) is organized for a religious purpose; (2) is engaged primarily in carrying out that religious purpose; (3) holds itself out to the public as an entity for carrying out that religious purpose; and (4) does not engage primarily or substantially in the exchange of goods or services for money beyond nominal amounts. One judge in *Spencer* took the view that the exemption is met if the entity is a non-profit and satisfies the first three factors, *id.* at 734 (O’Scannlain, J., concurring), and another judge took the view that the Salvation Army, for example, would satisfy the “nominal amounts” standard of the fourth factor, notwithstanding that it generates a large-dollar amount of sales revenue, because it “gives its homeless shelter and soup kitchen services away, or charges nominal fees.” *Id.* at 747 (Kleinfeld, J., concurring). In *Garcia*, 918 F.3d at 1003-04, the Ninth Circuit held that the Salvation Army is a religious organization under Title VII by applying the *Spencer* test under either judge’s formulation. In *LeBoon*, 503 F.3d at 226-29, the

Third Circuit found that a Jewish community center was a Title VII religious organization where, among other factors, the center “identified itself as Jewish,” relied on coreligionists for financial support, offered instructional programs with Jewish content, began its Board of Trustees meetings with biblical readings, and involved rabbis from three local synagogues in its management). *See also Killinger*, 113 F.3d at 199-200 (university founded as a theological institution by the Alabama Baptist State Convention qualified as a “religious educational institution” under Title VII; the court noted that all Trustees must be Baptist, the Convention is the university’s largest single source of funding, and the school’s charter designates its chief purpose as “the promotion of the Christian Religion throughout the world by maintaining and operating ... institutions dedicated to the development of Christian character in high scholastic standing.”).

[61] *LeBoon*, 503 F.3d at 229 (holding that a Jewish community center was a religious organization under Title VII, despite engaging in secular activities such as secular lectures and instruction with no religious content, employing overwhelmingly Gentile employees, and failing to ban non-kosher foods, and noting that a religiously affiliated newspaper and a religious college had also been found covered by the exemption). However, in *LeBoon*, the court did state that “the religious organization exemption would not extend to an enterprise involved in a wholly secular and for-profit activity.” *LeBoon*, 503 F.3d at 229; *see also Townley Eng’g & Mfg. Co.*, 859 F.2d at 619 (holding that evidence the company was for profit, produced a secular product, was not affiliated with a church, and did not mention a religious purpose in its formation documents, indicated that the business was not “primarily religious” and therefore did not qualify for the religious organization exemption). In *Garcia v. Salvation Army*, 918 F.3d 997, 1003 (9th Cir. 2019), the court cited *Townley* as the governing precedent for defining a religious organization.

[62] In *Hobby Lobby*, a case interpreting the term “person” under RFRA, the Supreme Court briefly referenced Title VII’s religious organization exemption in response to the U.S. Department of Health and Human Services’ (HHS) argument that “statutes like Title VII . . . expressly exempt churches and other nonprofit religious institutions but not-for-profit corporations.” 573 U.S. at 716. The Court did not expressly agree with HHS’s characterization but noted that other statutes “do exempt categories of entities that include for-profit corporations from laws that otherwise require these entities to engage in activities to which they object on grounds of conscience.” *Id.* “If Title VII and similar laws show anything, it is that Congress speaks with specificity when it intends a religious accommodation not to extend to for-profit corporations.” *Id.* at 717. It should be noted that, despite HHS’s

assertion in its *Hobby Lobby* brief, section 702(a) does not expressly distinguish “religious” entities based on for-profit or nonprofit status.

[63] *Cf. id.* at 702, 708 (in a non-Title VII case, rejecting the argument that “‘for-profit, secular corporations cannot engage in religious exercise’ within the meaning of [the Religious Freedom Restoration Act (RFRA)] or the First Amendment,” and holding that RFRA’s protections for any “person” whose religious free exercise is substantially burdened by the government is not limited to nonprofits and includes for-profit closely held corporations providing secular goods or services because “no conceivable definition of the term [‘person’] includes natural persons and nonprofit corporations, but not for-profit corporations”); see *Corp. of Presiding Bishop of Church of Jesus Christ of Latter-day Saints v. Amos*, 483 U.S. 327, 349 (1987) (O’Connor, J., concurring) (recognizing that it is an open question regarding application of Title VII’s religious organizations exemption under section 702 to for-profit organizations, specifically mentioning possible Establishment Clause issues with respect to for-profit organizations).

[64] 42 U.S.C. § 2000e-1(a). The Supreme Court, in dicta in a case focused on religious discrimination, has characterized section 702 by stating it “exempts religious organizations from Title VII’s prohibition against discrimination on the basis of religion.” *Amos*, 483 U.S. at 329. Section 703(e)(2) states, “it shall not be an unlawful employment practice” for certain schools, colleges, universities, or other educational institutions “to hire or employ employees of a particular religion.” 42 U.S.C. § 2000e-2(e)(2).

[65] See *Kennedy v. St. Joseph’s Ministries, Inc.*, 657 F.3d 189, 192 (4th Cir. 2011) (holding that exemption “does not exempt religious organizations from Title VII’s provisions barring discrimination on the basis of race, gender, or national origin”); *Boyd v. Harding Acad. of Memphis, Inc.*, 88 F.3d 410, 413 (6th Cir. 1996) (stating that the exemption “does not ... exempt religious educational institutions with respect to all discrimination”); *DeMarco v. Holy Cross High Sch.*, 4 F.3d 166, 173 (2d Cir. 1993) (“religious institutions that otherwise qualify as ‘employer[s]’ are subject to Title VII provisions relating to discrimination based on race, gender and national origin”); *Rayburn v. Gen. Conf. of Seventh-day Adventists*, 772 F.2d 1164, 1166 (4th Cir. 1985) (“While the language of § 702 makes clear that religious institutions may base relevant hiring decisions upon religious preferences, Title VII does not confer upon religious organizations a license to make those same decisions on the basis of race, sex, or national origin.”); *cf. Garcia*, 918 F.3d at 1004-5 (holding that Title VII retaliation and hostile work environment claims related to religious discrimination

were barred by religious organization exception, but adjudicating disability discrimination claim on the merits).

[66] 42 U.S.C. § 2000e-2(e) (“Notwithstanding any other provision of [Title VII], it shall not be an unlawful employment practice for [certain religious educational organizations] . . . to hire and employ employees of a particular religion . . .”).

[67] Courts take varying approaches regarding the causation standard and proof frameworks to be applied in assessing this defense. See *Kennedy*, 657 F.3d 189 at 193-94 (holding that plaintiff’s claims of discharge, harassment, and retaliation based on religion were covered by section 702(a) religious exemption and thus barred); *Curay-Cramer v. Ursuline Acad. of Wilmington, Del., Inc.*, 450 F.3d 130, 141 (3d Cir. 2006) (“Thus, we will not apply Title VII to [plaintiff’s sex discrimination] claim because Congress has not demonstrated a clear expression of an affirmative intention that we do so in situations where it is impossible to avoid inquiry into a religious employer’s religious mission or the plausibility of its religious justification for an employment decision.”); *DeMarco*, 4 F.3d at 170-71 (“[T]he [*McDonnell Douglas*] inquiry is directed toward determining whether the articulated purpose is the actual purpose for the challenged employment-related action.”); *EEOC v. Miss. Coll.*, 626 F.2d 477, 485 (5th Cir. 1980) (holding race and sex discrimination claims barred by section 702 exemption where religious employer presents “convincing evidence” that employment practice was based on the employee’s religion).

[68] “For the purposes of this subchapter . . . [t]he term “religion” includes all aspects of religious observance and practice, as well as belief.” 42 U.S.C. § 2000e(j).

[69] See *Curay-Cramer*, 450 F.3d at 141 (distinguishing the case “from one in which a plaintiff avers that truly comparable employees were treated differently following substantially similar conduct”); *DeMarco*, 4 F.3d at 171 (stating pretext inquiry “focuses on . . . whether the rule applied to the plaintiff has been applied uniformly”); *EEOC v. Fremont Christian Sch.*, 781 F.2d 1362, 1368 n.1 (9th Cir. 1986) (finding that Title VII’s exemption did not apply when the religious employer’s practice and justification were “conclusive[ly]” a pretext for sex discrimination).

[70] See *Curay-Cramer*, 450 F.3d at 141 (“[T]he existence of [section 702(a)] and our interpretation of its scope prevent us from finding a clear expression of an affirmative intention on the part of Congress to have Title VII apply when its application would involve the court in evaluating violations of [Catholic] Church doctrine.”); *DeMarco*, 4 F.3d at 170-71 (“The district court reasoned that, where employers proffered religious reasons for challenged employment actions,

application of the *McDonnell Douglas* test would require ‘recurrent inquiry as to the value or truthfulness of church doctrine,’ thus giving rise to constitutional concerns. However, in applying the *McDonnell Douglas* test to determine whether an employer’s putative purpose is a pretext, a fact-finder need not, and indeed should not, evaluate whether a defendant’s stated purpose is unwise or unreasonable. Rather, the inquiry is directed toward determining whether the articulated purpose is the actual purpose for the challenged employment-related action.” (citations omitted)); *cf. Burwell v. Hobby Lobby Stores, Inc.*, 573 U.S. 682, 725 (2014) (in determining whether an agency rule contravened a closely held corporation’s rights under the Religious Freedom Restoration Act, “it is not for the Court to say that . . . religious beliefs are mistaken or unreasonable”; rather the Court’s “‘narrow function . . . is to determine’ whether the plaintiffs’ asserted religious belief reflects ‘an honest conviction’”).

[71] *Fremont Christian Sch.*, 781 F.2d at 1367 n.1; *see also Miss. Coll.*, 626 F.2d at 486 (if evidence disclosed that the college “in fact” did not consider its religious preference policy in determining which applicant to hire, section 702 did not bar EEOC investigation into applicant’s sex discrimination claim).

[72] *Fremont Christian Sch.*, 781 F.2d at 1366 (quoting *Miss. Coll.*, 626 F.2d at 485).

[73] *See Garcia v. Salvation Army*, 918 F.3d 997, 1007 (9th Cir. 2019) (holding that Title VII’s religious organizations exemption is not jurisdictional and can be waived if not timely raised in litigation). “Because Congress did not rank the religious exemption as jurisdictional, this Court will ‘treat the restriction as nonjurisdictional in character.’” *Smith v. Angel Food Ministries, Inc.*, 611 F. Supp. 2d 1346, 1351 (M.D. Ga. 2009) (quoting *Arbaugh*, 546 U.S. 500, 515 (2006)).

[74] *See Corp. of the Presiding Bishop of the Church of Jesus Christ of Latter-Day Saints v. Amos*, 483 U.S. 327, 339 (1987) (addressing the issue of whether the § 702 exemption to the secular nonprofit activities of religious organizations violates the Establishment Clause of the First Amendment, the Court held that “as applied to the nonprofit activities of religious employers, § 702 is rationally related to the legitimate purpose of alleviating significant governmental interference with the ability of religious organizations to define and carry out their religious missions”); *Kennedy v. St. Joseph’s Ministries, Inc.*, 657 F.3d 189, 192 (4th Cir. 2011) (“The revised [religious organization exemption] provision, adopted in 1972, broadens the exemption to include any activities of religious organizations, regardless of whether those activities are religious or secular in nature.”).

[75] *Little v. Wuerl*, 929 F.2d 944, 951 (3d Cir. 1991) (holding religious organization exemption barred religious discrimination claim by parochial school teacher who was discharged for failing to follow church canonical procedures with respect to annulment of a first marriage before remarrying).

[76] See 42 U.S.C. § 2000e(j) (defining religion to include “all aspects of religious observance and practice, as well as belief”); see also *Little*, 929 F.2d at 951 (concluding that “the permission to employ persons ‘of a particular religion’ includes permission to employ only persons whose beliefs and conduct are consistent with the employer’s religious precepts”).

[77] *Hall v. Baptist Mem’l Health Care Corp.*, 215 F.3d 618, 624 (6th Cir. 2000); see, e.g., *Killinger v. Samford Univ.*, 113 F.3d 196, 200 (11th Cir. 1997) (holding that under religious organization exemption School of Divinity need not employ professor who did not adhere to the theology advanced by its leadership); *Little*, 929 F.2d at 951 (holding that religious organization exemption barred religious discrimination claim challenging parochial school’s termination of teacher who had failed to validate her second marriage by first seeking an annulment of her previous marriage through the canonical procedures of the Catholic church).

[78] See *Hall*, 215 F.3d at 625 (finding that Title VII’s religious organization exemption was not waived by the employer’s receipt of federal funding or holding itself out as an equal employment opportunity employer); *Little*, 929 F.3d at 951 (finding that Title VII’s religious organization exemption was not waived by Catholic school knowingly hiring a Lutheran teacher); see also *Garcia v. Salvation Army*, 918 F.3d 997, 1007 (9th Cir. 2019) (holding that Title VII’s religious organization exemption is not jurisdictional and can be waived).

[79] “In this context, there are circumstances, like those presented here, where a religious institution’s ability to ‘create and maintain communities composed solely of individuals faithful to their doctrinal practices’ will be jeopardized by a plaintiff’s claim of gender discrimination.” *Curay-Cramer*, 450 F.3d at 140-42 (affirming dismissal under the religious organization exemption and First Amendment grounds of Catholic school teacher’s claim that her termination for signing pro-choice newspaper advertisement constituted sex discrimination under Title VII; evaluating the plaintiff’s claim that male employees were treated less harshly for different conduct that violated church doctrine (e.g., opposition to the Iraq war) would require the court to “measure the degree of severity of various violations of Church doctrine” in violation of the First Amendment); see also *Miss. College*, 626 F.2d at

485 (holding that a plaintiff is barred from proceeding with a Title VII suit if a religious employer presents “convincing evidence” that the employment practice was based on a religious preference).

[80] *Id.* at 141 (“We distinguish this case from one in which a plaintiff avers that truly comparable employees were treated differently following substantially similar conduct . . . Requiring a religious employer to explain why it has treated two employees who have committed essentially the same offense differently poses no threat to the employer's ability to create and maintain communities of the faithful.”)

[81] 565 U.S. 171 (2012).

[82] *Our Lady of Guadalupe School v. Morrissey-Berru*, 140 S. Ct. 2049, 2061 (2020).

[83] *Hosanna-Tabor Evangelical Lutheran Church & Sch. v. EEOC*, 565 U.S. 171, 188-89 (2012).

[84] *Our Lady of Guadalupe*, 140 S. Ct. at 2060.

[85] *Hosanna-Tabor*, 565 U.S. at 195 n.4 (“We conclude that the exception operates as an affirmative defense to an otherwise cognizable claim, not a jurisdictional bar.”); *Our Lady of Guadalupe*, 140 S. Ct. at 2055.

[86] *Id.*; see also *Hosanna-Tabor*, 565 U.S. at 188 (agreeing that the ministerial exception “precludes application of such legislation to claims concerning the employment relationship between a religious institution and its ministers”).

There is a split in the courts on whether ministerial employees can bring EEO harassment claims. Compare *Elvig v. Calvin Presbyterian Church*, 375 F.3d 951, 953 (9th Cir. 2004) (holding that the ministerial exception does not bar sexual harassment and retaliation claims that do not “implicate the Church’s ministerial employment decisions”), and *Clement v. Roman Catholic Diocese of Erie*, No. 16-117, 2017 WL 2619134, at *4 n.3 (W.D. Pa. June 16, 2017) (ruling that sexual harassment claim by ministerial employee was not barred because *Hosanna-Tabor* expressly limited its holding to employment discrimination claims based on hiring and termination decisions and left open whether the ministerial exception bars other types of claims), with *Skrzypczak v. Roman Catholic Diocese of Tulsa*, 611 F.3d 1238, 1246 (10th Cir. 2010) (holding that minister’s hostile work environment claim was barred under ministerial exception), and *Preece v. Covenant Presbyterian Church*, No. 8:13CV188, 2015 WL 1826231, at *7 (D. Neb. Apr. 22, 2015) (holding that the

ministerial exception barred sexual harassment claim because it “clearly implicate[d] an internal church decision and management”). The Court in *Our Lady of Guadalupe* did not address this precise question. On one hand, the Court emphasized that “*the selection and supervision of the teachers upon whom the schools rely to do this work lie at the core of their mission.*” 140 S. Ct. at 2055 (emphasis added); see also *id.* at 2060 (“at a component of [a religious institution’s] autonomy is the selection of the individuals who play certain key roles”); *id.* (“a church’s independence on matters ‘of faith and doctrine’ requires the authority to select, supervise, and if necessary, remove a minister without interference by secular authorities.”). On the other hand, the Court stated broadly, “[w]hen a school with a religious mission entrusts a teacher with the responsibility of educating and forming students in the faith, *judicial intervention into disputes between the school and the teacher* threatens the school’s independence in a way that the First Amendment does not allow.” *Id.* at 2069 (emphasis added); see also *id.* at 2060 (“Under [the ministerial exception] rule, courts are bound to stay out of employment disputes involving those holding certain important positions with churches and other religious institutions.”).

[87] *Id.* at 2061.

[88] *Id.*

[89] *Id.* at 2060; see also *Hosanna-Tabor*, 565 U.S. at 184 (“The Establishment Clause prevents the Government from appointing ministers, and the Free Exercise Clause prevents it from interfering with the freedom of religious groups to select their own.”).

[90] *Our Lady of Guadalupe*, 140 S. Ct. at 2060.

[91] *Shaliehsabou v. Hebrew Home of Greater Wash., Inc.*, 363 F.3d 299, 310 (4th Cir. 2004) (Fair Labor Standards Act (“FLSA”)).

[92] See *Conlon v. InterVarsity Christian Fellowship*, 777 F.3d 829, 834 (6th Cir. 2015) (holding that to invoke the ministerial exception “an employer need not be a traditional religious organization such as a church, diocese, or synagogue, or an entity operated by a traditional religious organization”); see, e.g., *Penn v. N.Y. Methodist Hosp.*, 884 F.3d 416, 424-25 (2d Cir. 2018) (although it was a “close question,” the district court did not err in finding that hospital, which was no longer affiliated with the United Methodist Church and took steps to distance itself from its religious heritage, was “a ‘religious group,’ at least with respect to its Department of

Pastoral Care,” because the Department’s operations were “marked by clear or obvious religious characteristics”); *Grussgott v. Milwaukee Jewish Day Sch., Inc.*, 882 F.3d 655 (7th Cir. 2018) (Jewish day school was religious institution for purposes of applying the ministerial exception where school had a rabbi on staff and maintained its own chapel and Torah scrolls, and students were taught Jewish studies and Hebrew and engaged in daily prayer); *Conlon*, 777 F.3d at 829, 833-34 (parachurch campus student organization “whose purpose is to advance the understanding and practice of Christianity in colleges and universities” was a religious organization); *Shaliehsabou*, 363 F.3d 299 (Hebrew nursing home is a religious institution for purposes of applying the ministerial exception to the FLSA where its bylaws define it as a religious and charitable nonprofit and declare that its mission is to provide elder care to “aged of the Jewish faith in accordance with the precepts of Jewish law and customs”; pursuant to that mission, the nursing home maintained a rabbi on staff, employed mashgichim to ensure compliance with Jewish dietary laws, and placed a mezuzah on every resident’s doorpost); *Yin v. Columbia Int’l Univ.*, 335 F. Supp. 3d 803 (D.S.C. 2018) (religious university that “trains Christians for global missions, full-time vocational Christian ministry in a variety of strategic professions, and marketplace ministry” and “educates people from a biblical worldview” could invoke exception).

[93] See *Our Lady of Guadalupe*, 140 S. Ct. at 2058-59 (the schools maintained that their decisions were based on “classroom performance—specifically, [the teacher’s] difficulty in administering a new reading and writing program”—and “poor performance—namely, a failure to observe the planned curriculum and keep an orderly classroom”).

[94] 140 S. Ct. at 2066.

[95] *Hosanna-Tabor*, 565 U.S. at 190.

[96] *Our Lady of Guadalupe*, 140 S. Ct. at 2055, 2062; *Hosanna-Tabor*, 565 U.S. at 190-92 (holding that the ministerial exception applied to a parochial school teacher, because she pursued a rigorous religious course of study to become a “called” teacher, which included being ordained and receiving the title of “minister,” she held herself out as a minister of the church, she led daily prayers and occasional chapel services, and she provided religious instruction).

[97] *Hosanna-Tabor*, 565 U.S. at 193.

[98] *Our Lady of Guadalupe*, 140 S. Ct. at 2064.

[99] *Id.* at 2064, 2068.

[100] *Hosanna-Tabor*, 565 U.S. at 193-94 (pointing out that the “heads of congregations themselves often have a mix of duties, including secular ones”).

[101] 140 S. Ct. at 2063.

[102] *Id.* at 2067.

[103] *Id.* at 2064; see also *Hosanna-Tabor*, 565 U.S. at 194 (explaining that, while relevant, the considerations “cannot be considered in isolation, without regard to the nature of the religious functions performed”).

[104] *Id.*

[105] See *id.* at 2056, 2060, 2067 n.26, 2068-69; *Hosanna-Tabor*, 565 U.S. at 190.

[106] *Grussgott v. Milwaukee Jewish Day Sch., Inc.*, 882 F.3d 655, 655 (7th Cir. 2018) (finding claims by parochial school Hebrew and Jewish studies teacher barred); *Fratello v. Archdiocese of N.Y.*, 863 F.3d 190 (2d Cir. 2017) (finding claims by parochial school principal barred); *Lishu Lin v. Columbia Int’l Univ.*, 335 F. Supp. 3d 803 (D.S.C. 2018) (finding claims by faculty member with secular titles barred where she trained Christians for ministry and educated students from a biblical worldview to spread religious message).

[107] *Sterlinski v. Cath. Bishop of Chi.*, 934 F.3d 568 (7th Cir. 2019) (finding claim by church organist barred); *Cannata v. Catholic Diocese of Austin*, 700 F.3d 169 (5th Cir. 2012) (finding claims by church music director barred).

[108] *Penn v. N.Y. Methodist Hosp.*, 884 F.3d 416 (2d Cir. 2018) (finding claims by hospital chaplain barred, viewing chaplaincy department as a religious organization though hospital was not); *Conlon*, 777 F.3d 829 (finding claim by staff spiritual director of fellowship organization barred); *Shaliehsabou v. Hebrew Home of Greater Wash., Inc.*, 363 F.3d 299, 309 (4th Cir. 2004) (given “the importance of dietary laws to the Jewish religion,” “mashgiach” (kosher supervisor) at Hebrew Home was ministerial employee for purposes of FLSA).

[109] 140 S. Ct. at 2055, 2065, 2069.

[110] *Id.* at 2067 n.26.

[111] *Id.* at 2066.

[112] *Id.*

[113] See *Conlon*, 777 F.3d at 836 (explaining that “[t]he ministerial exception is a structural limitation imposed on the government by the Religion Clauses”).

[114] See *Fratello v. Archdiocese of N.Y.*, 863 F.3d 190, 198 (2d Cir. 2017) (stating that “the district court appropriately ordered discovery limited to whether [plaintiff] was a minister within the meaning of the exception” when it found that it could not determine whether the ministerial exception applied on a motion to dismiss).

[115] See *Lee v. Sixth Mount Zion Baptist Church*, 903 F.3d 113, 118 n.4 (3d Cir. 2018) (noting that although the district court first raised the ministerial exception, “the Church [wa]s not deemed to have waived it because the exception is rooted in constitutional limits on judicial authority”); *Conlon*, 777 F.3d at 836 (“The Court’s clear language [in *Hosanna-Tabor*] recognizes that the Constitution does not permit private parties to waive the First Amendment’s ministerial exception.”); *but see Hamilton v. Southland Christian School, Inc.*, 680 F.3d 1316, 1318 (11th Cir. 2012) (finding that the school had waived its ministerial exception defense on appeal by not sufficiently arguing it in its brief).

[116] The First Amendment religion and speech clauses provide that “Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof; or abridging the freedom of speech.” RFRA, 42 U.S.C. § 2000bb-1(a) and (b), provides: “Government shall not substantially burden a person’s exercise of religion even if the burden results from a rule of general applicability, except . . . if it demonstrates that application of the burden to the person—(1) is in furtherance of a compelling governmental interest; and (2) is the least restrictive means of furthering that compelling governmental interest.” RFRA defines “government” to include “a branch, department, agency, instrumentality, and official (or other person acting under color of law) of the United States.” *Id.* § 2000bb-2(1). “Although the claim is statutory, RFRA protects First Amendment free-exercise rights,” *Korte v. Sebelius*, 735 F.3d 654, 666 (7th Cir. 2013), because it was enacted in response to *Employment Division v. Smith*, 494 U.S. 872, 887 (1990), and designed to “restore the compelling interest test as set forth in *Sherbert v. Verner*, 374 U.S. 398 (1963) and *Wisconsin v. Yoder*, 406 U.S. 205 (1972) and to guarantee its application in all cases where free exercise of religion is substantially burdened.” 42 U.S.C. § 2000bb(b)(1). The First Amendment applies only to restrictions imposed by the government—federal or state—not by private parties. See *Cantwell v. Connecticut*, 310 U.S. 296 (1940). RFRA applies only to restrictions imposed by the federal government, not by state

governments or private parties. See 42 U.S.C. § 2000bb-2(1); *City of Boerne v. Flores*, 521 U.S. 507 (1997); *Guam v. Guerrero*, 290 F.3d 1210 (9th Cir. 2002); *Kikumura v. Hurley*, 242 F.3d 950 (10th Cir. 2001).

[117] See e.g., *Curay-Cramer v. Ursuline Acad. of Wilmington, Del., Inc.*, 450 F.3d 130, 138 (3d Cir. 2006) (claim that Catholic school engaged in gender discrimination in violation of Title VII could raise “serious constitutional questions” because it required more than limited inquiry into pretext); cf. *Bostock v. Clayton Cnty.*, 140 S. Ct. 1731, 1754 (2020) (“Because RFRA operates as a kind of super statute, displacing the normal operation of other federal laws, it might supersede Title VII’s commands in appropriate cases.”).

Some courts have examined an employer’s defense to an EEOC action that a nondiscrimination requirement would conflict with their exercise of religion under RFRA, although unsuccessfully thus far. See *EEOC v. R.G. & G.R. Harris Funeral Homes, Inc.*, 884 F.3d 560 (6th Cir. 2018) (considering but rejecting employer’s defense that application of Title VII sex nondiscrimination requirement to its hiring decisions would substantially burden its exercise of religion under RFRA); *EEOC v. Preferred Mgmt. Corp.*, 216 F. Supp. 2d 763, 810 (S.D. Ind. 2002) (same for Title VII religious nondiscrimination and non-harassment requirements). Other courts have held that a RFRA defense does not apply in suits involving only private parties. See, e.g., *Listeck v. Off. Comm. of Unsecured Creditors*, 780 F.3d 731, 736-37 (7th Cir. 2015) (RFRA inapplicable where the government is not a party, in part because if the government is not a party, it cannot demonstrate a “compelling government interest” as RFRA requires); *Gen. Conf. Corp. of Seventh-Day Adventists v. McGill*, 617 F.3d 402 (6th Cir. 2010) (finding RFRA inapplicable in trademark infringement case). The Second Circuit has held that an employer could raise RFRA as defense to an employee’s Age Discrimination in Employment Act (ADEA) claim, because the ADEA is enforceable both by the EEOC and private litigants, but a number of other circuits have disagreed with that reasoning. Compare *Hankins v. Lyght*, 441 F.3d 96, 103 (2d Cir. 2006) with *General Conference Corp. of Seventh Day Adventists v. McGill*, 617 F.3d 402, 411 (6th Cir. 2006) (declining to follow *Hankins* based on the text in RFRA), *Tomic v. Catholic Diocese of Peoria*, 442 F.3d 1036, 1042 (7th Cir. 2006) (“The [*Hankins*] decision is unsound. RFRA is applicable only in suits to which the government is a party.”), abrogated on other grounds by *Hosanna-Tabor Evangelical Lutheran Church and Sch. v. EEOC*, 132 S. Ct. 694 (2012), and *Mathis v. Christian Heating Air Conditioning, Inc.*, 158 F. Supp. 3d 317, 326 (E.D. Pa. 2016) (disagreeing with *Hankins* and finding that RFRA does not apply if the government is not a party). One circuit court has found that RFRA’s broad definition of “government” to include

any branch of the federal government might allow a court to find sufficient government involvement in lawsuits between private parties to allow for a RFRA defense to apply. See *In re Young*, 82 F.3d 1407, 1417 (8th Cir. 1996) (“The bankruptcy code is federal law, the federal courts are a branch of the United States, and our decision in the present case would involve the implementation of federal bankruptcy law.”), *vacated on other grounds*, 117 S. Ct. 2502 (1997), *aff’d on remand*, 141 F.3d 854 (1998). See also *Tanzin v. Tanzir*, 141 S. Ct. 486, 493 (2020) (“We conclude that RFRA’s express remedies provision permits litigants, when appropriate, to obtain money damages against federal officials in their individual capacities.”).

[118] See, e.g., *Brown v. Polk Cnty.*, 61 F.3d 650, 659 (8th Cir. 1995) (en banc) (rejecting county employers’ argument in Title VII religious discrimination case that they were allowed to prohibit religious expression altogether in the workplace to avoid Establishment Clause claims against them).

[119] See *Guidelines on Religious Exercise and Religious Expression in the Federal Workplace* (Aug. 14, 1997),

<https://clintonwhitehouse2.archives.gov/WH/New/html/19970819-3275.html> (<https://clintonwhitehouse2.archives.gov/WH/New/html/19970819-3275.html>)

(last visited Jan. 8, 2021) [hereinafter *Federal Workplace Guidelines*]. Although the *Federal Workplace Guidelines* are directed at federal employers, they provide useful guidance for state and local government employers, as well as private employers in some circumstances. In addition, the U.S. Department of Justice maintains a website, www.firstfreedom.gov (<http://www.firstfreedom.gov>), which provides information on a variety of constitutional and statutory religious discrimination issues.

[120] See, e.g., *Knight v. Conn. Dep’t of Pub. Health*, 275 F.3d 156, 164–65 (2d Cir. 2001) (holding that state agency did not violate either Title VII or the First Amendment Free Exercise Clause by refusing to allow employee to evangelize clients of state agency while performing job duties; in addition, employer would have risked First Amendment Establishment Clause violation by permitting the accommodation); cf. *Fraternal Order of Police v. City of Newark*, 170 F.3d 359 (3d Cir. 1999) (Alito, J.) (holding that police department violated Sunni Muslim officer’s First Amendment free exercise rights by refusing to make a religious exception to its “no beard” policy to accommodate his beliefs, while exempting other officers for medical reasons); *Draper v. Logan Cnty. Pub. Lib.*, 403 F. Supp. 2d 608 (W.D. Ky. 2005) (holding that public library violated an employee’s First Amendment free speech

and free exercise rights by prohibiting her from wearing a necklace with a cross ornament).

[121] See *Harrell v. Donahue*, 638 F.3d 975, 984 (8th Cir. 2011) (holding RFRA claims alleging religious discrimination in federal employment are barred because “Title VII provides the exclusive remedy for [] claims of religious discrimination”); *Francis v. Mineta*, 505 F.3d 266, 272 (3d Cir. 2007) (stating that “[i]t is equally clear that Title VII provides the exclusive remedy for job-related claims of federal religious discrimination, despite [plaintiff’s] attempt to rely upon the provisions of RFRA”). But see *Lister v. Def. Logistics Agency*, No. 2:05-CV-495, 2006 WL 162534, at *3 (S.D. Ohio Jan. 20, 2006) (denying defendants’ motion to dismiss as to RFRA claim and finding that “Title VII does not preclude Plaintiff from pursuing claims under the Fifth Amendment to the United States Constitution and RFRA” because “[a]lthough the claims arise from the same factual circumstance as the Title VII claim, the claims are distinct from Plaintiff’s claim for employment discrimination and therefore are not precluded by Title VII”). In addition, one appellate court has held that a federal employee is not preempted from bringing a RFRA claim against another agency (not his employer) to challenge that agency’s action interfering with employment. See, e.g., *Tagore v. United States*, 735 F.3d 324 (5th Cir. 2013) (allowing employee’s RFRA claim to proceed against agency that enforced building security regulations and denied her permission to enter building while wearing a kirpan).

[122] See, e.g., *Hobby Lobby*, 573 U.S. at 733 (rejecting “the possibility that discrimination in hiring, for example on the basis of race, might be cloaked as religious practice to escape legal sanction” under RFRA, and stating that the decision “provides no such shield”); *EEOC v. R.G. & G.R. Harris Funeral Homes, Inc.*, 884 F.3d 560, 589-97 (6th Cir. 2018) (holding that EEOC’s enforcement of Title VII did not violate RFRA), *aff’d on other grounds sub nom. Bostock v. Clayton Cnty.*, 140 S. Ct. 1731 (2020); ***EEOC v. Preferred Mgmt. Corp.*, 216 F. Supp. 2d 763, 810-11 (S.D. Ind. 2002)** ([https://1.next.westlaw.com/Link/Document/FullText?findType=Y&serNum=2002160113&pubNum=0004637&originatingDoc=I553accf0223811e8a5e6889af90df30f&refType=RP&fi=co_pp_sp_4637_810&originatio nContext=document&transitionType=DocumentItem&contextData=\(sc.DocLink\)#co_pp_sp_4637_810](https://1.next.westlaw.com/Link/Document/FullText?findType=Y&serNum=2002160113&pubNum=0004637&originatingDoc=I553accf0223811e8a5e6889af90df30f&refType=RP&fi=co_pp_sp_4637_810&originatio nContext=document&transitionType=DocumentItem&contextData=(sc.DocLink)#co_pp_sp_4637_810)) (holding under RFRA that “even if the EEOC had substantially burdened [the employer’s] religious beliefs or practices in prosecuting this matter, its conduct still comports with the RFRA’s mandates [because] [t]here is a ‘compelling government interest’ in creating such a burden [–] the eradication of employment discrimination based on the criteria identified in Title VII, including religion” – and “the intrusion is the least restrictive means that

Congress could have used to effectuate its purpose”); see *also* *Bostock*, 140 S. Ct. at 1753-54 (holding that discrimination based on sexual orientation or transgender status is actionable under Title VII’s sex discrimination prohibition, but declining to address how an employer’s religious convictions about sexual orientation or transgender status are protected under Title VII’s statutory religious organization exception, RFRA, or the First Amendment’s ministerial exception, noting that how doctrines “protecting religious liberty interact with Title VII are questions for future cases”); *Bob Jones Univ. v. United States*, 461 U.S. 574, 604 (1983) (holding that the compelling governmental interest in eradicating racial discrimination in education substantially outweighed the burden of denying tax exempt status under 26 U.S.C. § 501(c)(3) to a religious university that engage in race discrimination).

[123] *Abramson v. William Paterson Coll. of N.J.*, 260 F.3d 265, 281 (3d Cir. 2001) (explaining that prima facie case and evidentiary burdens of an employee alleging religious discrimination mirror those of an employee alleging race or sex discrimination). A disparate impact analysis could also apply in the religion context, particularly in the area of recruitment and hiring, or with respect to dress codes or other facially neutral rules. See, e.g., *Barrow v. Greenville Indep. Sch. Dist.*, 480 F.3d 377 (5th Cir. 2007) (affirming summary judgment, citing lack of statistical evidence for employer on Title VII claim brought by teacher who asserted policy favoring teachers whose children attended the public schools had a disparate impact on those whose children attended private school for religious rather than secular reasons); *Muhammad v. N.Y. City Transit Auth.*, 52 F. Supp. 3d 468, 485-88 (E.D.N.Y. 2014) (holding that disparate impact religious discrimination claim could proceed where policy of transferring to non-driver positions those with objections to the headwear portion of employer’s uniform policy disproportionately affected Muslim employees, employer’s desire to maintain customer comfort and boost employee morale did not amount to a legitimate business necessity for its transfer practice, and availability of a less restrictive alternative could be proven from employer’s own prior practice of permitting drivers to wear khimars as long as they matched their uniforms); *Jenkins v. N.Y. City Transit Auth.*, 646 F. Supp. 2d 464, 470-71 (S.D.N.Y. 2009) (holding that Pentecostal employee stated a claim under Title VII for disparate impact based on religion challenging dress code requiring female bus operators to wear pants rather than long skirts). However, because the reasonable accommodation/undue hardship analysis is usually used when a neutral work rule adversely affects an employee’s religious practice, see *infra* § 12-IV, disparate impact analysis is seldom used in religion cases.

[124] See 42 U.S.C. § 2000e-3(b).

[125] *Id.*; 42 U.S.C. § 2000e-2(e)(1); see also *infra* §§ 12-I-C, 12-II-D.

[126] See, e.g., *Patterson v. Ind. Newspapers Inc.*, 589 F.3d 357, 365 (7th Cir. 2009) (ruling that plaintiff may proceed on a claim that “her supervisors, though also Christian, did not like her brand of Christianity,” because “[t]he issue is whether plaintiff’s specific religious beliefs were a ground for” an adverse employment action); *Preferred Mgmt. Corp.*, 216 F. Supp. 2d at 813 (finding evidence raised a reasonable inference that failure to hire was based on religion where applicant was told “[y]ou damned humanists are ruining the world” and will “burn in hell forever”).

[127] It is not an unlawful employment practice for an employment agency to comply with an employer’s request for applicants of a particular religion “in those relatively rare instances where religion . . . is a bona fide occupational qualification reasonably necessary to the normal operation of that particular business or enterprise.” 42 U.S.C. § 2000e-2(e)(1). i); see also *supra* §§ 12-I-C-1, 12-I-C-2 (discussing religious organization exemption and ministerial exception), 12-II-D (discussing BFOQ).

[128] See *EEOC v. Abercrombie & Fitch Stores, Inc.*, 135 S. Ct. 2028, 2033 (2015) (“An employer may not make an applicant’s religious practice, confirmed or otherwise, a factor in employment decisions. . . . If the applicant actually requires an accommodation of that religious practice, and the employer’s desire to avoid the prospective accommodation is a motivating factor in his decision, the employer violates Title VII” absent an available defense or exemption); see also *Commission Guidelines*, 29 C.F.R. § 1605.3.

[129] See 42 U.S.C. § 2000e-3(b).

[130] See *Abercrombie & Fitch Stores, Inc.*, 135 S. Ct. at 2033 (holding Title VII prohibits failing to hire an applicant in order to avoid accommodating the applicant’s religious practice, whether or not the applicant informed the employer of the need for an accommodation).

[131] See, e.g., *Muhammad v. N.Y. City Transit Auth.*, 52 F. Supp. 3d 468, 485-87 (E.D.N.Y. 2014) (analyzing disparate impact claim arising from disproportionate effect of employer’s dress code provision on those wearing certain types of religious garb); *Jenkins v. N.Y. City Transit Auth.*, 646 F. Supp. 2d 464, 470-71 (S.D.N.Y. 2009) (holding that Pentecostal employee stated a claim under Title VII for religion-based

disparate impact when challenging dress code requiring female bus operators to wear pants rather than long skirts).

[132] In *Noyes v. Kelly Servs. Inc.*, 488 F.3d 1163, 1165 (9th Cir. 2007), the plaintiff alleged “reverse religious discrimination” when she was not promoted because she did not follow the religious beliefs of her supervisor and management, who were members of a small religious group and favored and promoted other members of the religious group. The court ruled that while the employee did not adhere to a particular religion, the fact that she did not share the employer’s religious beliefs was the basis for the alleged discrimination against her, and the evidence was sufficient to create an issue for trial on whether the employer’s decision to promote another employee was a pretext for religious discrimination. *Id.* at 1168-69.

[133] See, e.g., *Campos v. City of Blue Springs*, 289 F.3d 546 (8th Cir. 2002) (holding that evidence supported finding of religiously motivated constructive discharge based on plaintiff’s Native American spiritual beliefs); *EEOC v. Univ. of Chi. Hosp.*, 276 F.3d 326 (7th Cir. 2002) (holding that evidence was sufficient to proceed to trial in case brought on behalf of recruiter alleging constructive discharge based on her evangelical religious beliefs); *Altman v. Minn. Dep’t of Corr.*, 251 F.3d 1199, 1203 (8th Cir. 2001) (holding, in case raising both Title VII and First Amendment claims, that an employer may not discipline employees for conduct because it is religious in nature if it permits such conduct by other employees when not motivated by religious beliefs); *Tincher v. Wal-Mart Stores*, 118 F.3d 1125, 1131 (7th Cir. 1997) (holding a reasonable jury could conclude that employer’s articulated reason for the discharge of a Seventh-day Adventist was pretextual and that the real reason was religious discrimination because of the inconvenience caused by employee’s inability to work on Saturdays). However, not all employer decisions affect a term, condition, or privilege of employment as required to be actionable as disparate treatment. See, e.g., *Goldmeier v. Allstate Ins. Co.*, 337 F.3d 629 (6th Cir. 2003) (holding a resignation 53 days prior to the effective date of an employer’s policy that would have posed conflict with employees’ religious beliefs did not constitute constructive discharge).

[134] See *Haji v. Columbus City Sch.*, 621 F. App’x 309 (6th Cir. 2015) (in case involving a school employee who violated the employer’s attendance policy by leaving early to attend a local mosque without signing out or obtaining permission to leave, holding that the plaintiff failed to present evidence that non-Muslims were treated more favorably, or other evidence supporting an inference of discrimination).

[135] *Cf. Ansonia Bd. of Educ. v. Philbrook*, 479 U.S. 60, 71 (1986) (holding that a benefit “that is part and parcel of the employment relationship may not be doled out in a discriminatory fashion, even if the employer would be free . . . not to provide the benefit at all” (quoting *Hishon v. King & Spalding*, 467 U.S. 69, 75 (1984))). However, at least one court has held that a private employer providing company resources to recognized employee “affinity groups” does not violate Title VII by denying this privilege to any group promoting or advocating any religious or political position, where the company excluded not only groups advocating a particular religious position but also those espousing religious indifference or opposition. See *Moranski v. Gen. Motors Corp.*, 433 F.3d 537 (7th Cir. 2005).

[136] See *Delelegne v. Kinney Sys., Inc.*, No. 02–11657–RGS, 2004 WL 1281071 (D. Mass. June 10, 2004) (holding that Ethiopian Christian parking garage cashier could proceed to trial on claims of religious harassment and discriminatory termination where he was not allowed to bring a Bible to work, pray, or display religious pictures in his booth, while Somali Muslim employees were permitted to take prayer breaks and to display religious materials in their booths).

[137] This type of fact pattern also arises where there is no comparator. See, e.g., *Dixon v. Hallmark Cos.*, 627 F.3d 849 (11th Cir. 2010) (ruling that apartment complex property manager could proceed to trial on claim challenging termination for violating the employer’s religious displays policy by refusing to remove a poster of flowers with the words “Remember the Lilies . . . Matthew 6:28” she had hung in the on-site management office, where the employer also terminated the manager’s husband, telling him, “You’re fired too. You’re too religious.” This fact pattern may also give rise to a denial of accommodation issue. See *infra* § 12-IV-C-6.

[138] See *infra* § 12-III.

[139] See *infra* § 12-IV. As explained above, Title VII defines “religion” as “all aspects of religious observance and practice, as well as belief, unless an employer demonstrates that he is unable to reasonably accommodate to an employee’s or prospective employee’s religious observance or practice without undue hardship on the conduct of the employer’s business.” 42 U.S.C. § 2000e(j).

[140] Determining whether religious expression disrupts coworkers or customers is discussed in §§ 12-III-C and 12-IV-C-6, *infra*. Additionally, in a government workplace, the First Amendment Free Exercise Clause and Establishment Clause may affect the employer’s or employee’s ability to restrict or engage in religious expression. See *supra* § 12-I-C-3 (“Interaction of Title VII with the First Amendment

and the Religious Freedom Restoration Act (RFRA)"); see also *Federal Workplace Guidelines*, *supra* note 119, §§ 2-B, 2-E (noting implications of RFRA for neutral rules that burden religion in the federal workplace).

[141] However, there may be special circumstances where religion can be a bona fide occupational qualification for a particular position. See *infra* § 12-II-D (discussing when religion can be a bona fide occupational qualification).

[142] Cf. 42 U.S.C. § 2000e-2(g) (permitting covered entities to discharge or refuse to “hire and employ” or refer an individual who does not meet federal security requirements). See *infra* § 12-IV-B-5 (discussing security requirements and Title VII’s accommodation obligation).

[143] 42 U.S.C. § 2000e-2(e)(1).

[144] Compare *Abrams v. Baylor Coll. of Med.*, 805 F.2d 528 (5th Cir. 1986) (holding that being non-Jewish was not a BFOQ for a university which had a contract to supply physicians on rotation at a Saudi Arabian hospital when the hospital presented no evidence to support its contention that Saudi Arabia would actually have refused an entry visa to a Jewish faculty member), and *Rasul v. Dist. of Columbia*, 680 F. Supp. 436 (D.D.C. 1988) (holding that Department of Corrections failed to demonstrate that Protestant religious affiliation was a BFOQ for position as prison chaplain because chaplains were recruited and hired on a facility-wide basis and were entrusted with the job of planning, directing, and maintaining a total religious program for all inmates, whatever their respective denominations), with *Kern v. Dynalectron Corp.*, 577 F. Supp. 1196 (N.D. Tex. 1983) (holding that requirement that pilot convert to Islam was a BFOQ, where not based on a preference of contractor performing work in Saudi Arabia, but on the fact that non-Muslim employees caught flying into Mecca would, under Saudi Arabian law, be beheaded), *aff’d*, 746 F.2d 810 (5th Cir. 1984).

[145] 42 U.S.C. § 2000e-2(a)(1).

[146] *Faragher v. Boca Raton*, 524 U.S. 775, 786 (1998) (quotation marks and citations omitted).

[147] *Id.*

[148] *Meritor Sav. Bank, FSB v. Vinson*, 477 U.S. 57, 65 (1986).

[149] *Meritor Sav. Bank*, 477 U.S. at 67 (quoting *Henson v. City of Dundee*, 682 F.2d 897, 904 (11th Cir. 1982) (alteration in *Meritor*)).

[150] *Meritor Sav. Bank*, 477 U.S. at 66; see also *Faragher*, 524 U.S. at 786-88.

[151] *Meritor Sav. Bank*, 477 U.S. at 65.

[152] *Id.* at 66; see, e.g., *Venters v. City of Delphi*, 123 F.3d 956 (7th Cir. 1997) (holding that an employee who was terminated after she disagreed with supervisor's religious beliefs raised a triable Title VII harassment claim based on two separate theories of harassment liability: that a supervisor conditioned a "tangible employment benefit" upon "adher[ing] to [her supervisor's set of religious values," and that the employer created a hostile work environment).

[153] See *Martin v. Stoops Buick, Inc.*, No. 1:14-cv-00298-RLY-DKL, 2016 WL 2989037, at *6 (S.D. Ind. May 24, 2016) (denying summary judgment for employer where a reasonable juror could find that plaintiff's termination was motivated by her refusal to continue reading the Bible with her manager); *Scott v. Montgomery Cnty. Sch. Bd.*, 963 F. Supp. 2d 544, 553-57 (W.D. Va. 2013) (holding that a reasonable jury could find plaintiff's rejection of her supervisor's overtures, including declining her requests to join Bible study group, attend religious retreat, or begin each day with prayer before work, resulted in negative performance evaluations and then the non-renewal of her contract, even though the allegations did not establish a hostile work environment claim); *Rice v. City of Kendallville*, No. 1:07-CV-180-TS, 2009 WL 857463, at *8-9 (N.D. Ind. Mar. 31, 2009) (holding that discrimination could be found where plaintiff was terminated but her coworker, who engaged in same misconduct but attended their supervisor's church, was not); see also *Venters*, 123 F.3d at 964 (holding that employee established that she was discharged on the basis of her religion after supervisor, among other things, repeatedly called her "evil" and stated that she had to share his Christian beliefs in order to be a good employee).

[154] Many of the example's facts are taken from *Sattar v. Motorola, Inc.*, 138 F.3d 1164 (7th Cir. 1998). However, in *Sattar* the plaintiff alleged only discriminatory discharge, not harassment. The court of appeals upheld summary judgment in favor of the employer, ruling that the employer had supplied sufficient evidence that it had discharged the plaintiff for deficient performance and poor leadership skills, and that the plaintiff had not supplied evidence that these reasons were pretext for religious discrimination.

[155] Courts may come to different conclusions regarding whether job duties and religious beliefs conflict and, in turn, whether there is a duty to accommodate at all. *Compare Summers v. Whitis*, No. 4:15-cv-00093-RLY-DML, 2016 WL 7242483, at *5-7 (S.D. Ind. Dec. 15, 2016) (holding that deputy county clerk terminated for refusing on religious grounds to process same-sex marriage licenses did not prove failure to accommodate because there was no conflict between her religious beliefs and her job duties, where the duties were purely administrative, and she was not required to perform or attend marriage ceremonies, personally issue licenses or certificates, say congratulations, offer a blessing, or express religious approval), *with Slater v. Douglas Cnty.*, 743 F. Supp. 2d 1188, 1193-95 (D. Or. 2010) (holding that county clerk's office employee could proceed with denial of accommodation and discriminatory termination claim arising from her religious refusal to process same-sex domestic partnership registration paperwork).

[156] See *Pedersen v. Casey's Gen. Stores, Inc.*, 978 F. Supp. 926, 929 (D. Neb. 1997) (awarding relief following jury finding that employer's refusal to accommodate employee's need to have Easter day off, while knowing that she could not compromise her religious needs and where it would not have posed an undue hardship, amounted to constructive discharge in violation of Title VII); see also *Venters*, 123 F.3d at 972 (ruling that "the accommodation framework . . . has no application when the employee alleges that he was fired because he did not share or follow his employer's religious beliefs").

[157] *Harris v. Forklift Sys., Inc.*, 510 U.S. 17, 21 (1993) (internal quotation marks and citation omitted).

[158] *Meritor Sav. Bank, FSB v. Vinson*, 477 U.S. 57, 67 (1986); see also *Dediol v. Best Chevrolet, Inc.*, 655 F.3d 435, 443 (7th Cir. 2011) (stating the prima facie case of hostile work environment based on religion).

[159] See *Rivera v. P.R. Aqueduct & Sewers Auth.*, 331 F.3d 183, 189-91 (1st Cir. 2003) ("A constellation of factors led to the friction between Rosario and her coworkers, but no reasonable fact finder could conclude on the basis of the incidents we have described or the general atmosphere in the office that one of these factors was an antipathy towards Rosario's underlying religious convictions."); *Marcus v. West*, No. 99 C 0261, 2002 WL 1263999, at *11 (N.D. Ill. June 3, 2002) (finding that mistreatment of Sanctified Pentecostal Christian employee was not because of religion, where supervisor mistreated all of her employees and had poor management and interpersonal skills).

[160] See *Rasmy v. Marriott Int'l, Inc.*, 952 F.3d 379, 387-88 & n.34 (2d Cir. 2020); *Turner v. Barr*, 811 F. Supp. 1, 3-4 (D.D.C. 1993) (finding that hostile environment was created where Jewish employee was subjected to a “joke” about the Holocaust, denied opportunity to work overtime, and ridiculed as a “turnkey,” even though the latter two incidents did not refer to religion, because the facts showed that he was singled out for such treatment because of his religion).

[161] See *EEOC v. Sunbelt Rentals, Inc.*, 521 F.3d 306, 315-19 (4th Cir. 2008) (reversing summary judgment for the employer and remanding the case for trial because a reasonable fact finder could conclude that a Muslim employee who wore a kufi as part of his religious observance was subjected to hostile work environment religious harassment when fellow employees repeatedly called him “Taliban” and “towel head,” made fun of his appearance, questioned his allegiance to the United States, suggested he was a terrorist, and made comments associating all Muslims with senseless violence); *EEOC v. WC&M Enters., Inc.*, 496 F.3d 393, 398-401 (5th Cir. 2007) (reversing summary judgment for the employer and remanding the case for trial because a reasonable fact finder could conclude that harassment initiated after September 11, 2001, against a car salesman who was born in India and was a practicing Muslim, was severe or pervasive and motivated by his national origin and religion); *EEOC v. T-N-T Carports, Inc.*, No. 1:09-CV-27, 2011 WL 1769352, at *4 (M.D.N.C. May 9, 2011) (holding that evidence could show harassment was motivated by religious animosity where coworkers suggested employee, a devout Christian, belonged to a cult and was a devil worshipper; physically intimidated her while simultaneously using derogatory words about her religion; called her “crazy” about her religious beliefs; drew devil horns, a devil tail, and a pitchfork on her Christmas photo; used profanity followed by mock apologies; and cursed the Bible and teased about Bible reading). In *Sunbelt*, the Fourth Circuit held: “we cannot regard as ‘merely offensive,’ and thus ‘beyond Title VII’s purview,’ *Harris*, 510 U.S. at 21, constant and repetitive abuse founded upon misperceptions that all Muslims possess hostile designs against the United States, that all Muslims support jihad, that all Muslims were sympathetic to the 9/11 attack, and that all Muslims are proponents of radical Islam.” 521 F.3d at 318.

[162] See *Abramson v. William Paterson Coll. of N.J.*, 260 F.3d 265, 279 (3d Cir. 2001) (holding that supervisor criticizing professor’s refusal to work on her Sabbath, scheduling meetings on Jewish holidays, and charging her for leave on those holidays could be found to have “infected [professor’s] work experience” because of her religion).

[163] *Chamberlin v. 101 Realty, Inc.*, 915 F.2d 777, 784 (1st Cir. 1990); see *Mahler v. First Dakota Title Ltd. P’ship*, 931 F.3d 799, 806 (8th Cir. 2019) (“Harassing conduct is considered unwelcome if it was uninvited and offensive.”).

[164] In *Harris v. Forklift Systems, Inc.*, 510 U.S. 17, 21-22 (1993), the Court clarified that a complainant alleging a hostile work environment must establish not only that the alleged harassment was objectively hostile but also that she subjectively viewed the conduct as hostile. Some courts continue to identify unwelcomeness as a separate element of a hostile work environment claim, see, e.g., *Maldonado-Cátala v. Municipality of Naranjito*, 876 F.3d 1, 10 (1st Cir. 2017); *Patton v. Jacobs Eng’g Grp., Inc.*, 874 F.3d 437, 445 (5th Cir. 2017), and other courts address unwelcomeness as part of assessing subjective hostility, stating that conduct that is subjectively hostile must also logically be unwelcome, see, e.g., *Johnson v. Advocate Health & Hosps. Corp.*, 892 F.3d 887, 904 (7th Cir. 2018) (holding that because a reasonable jury could find that the conduct was unwelcome, there was an issue of material fact regarding subjective hostility); *Kokinchak v. Postmaster Gen. of the U.S.*, 677 F. App’x 764, 767 (3d Cir. 2017) (treating unwelcomeness and subjective hostility as the same issue).

[165] See *WC&M Enters.*, 496 F.3d at 400-01 (finding religious and national origin harassment claim could be based on having been referred to as a “Muslim extremist” and constantly called “Taliban,” among other terms); *Khan v. United Recovery Sys., Inc.*, No. H-03-2292, 2005 WL 469603, at *16-17 (S.D. Tex. Feb. 28, 2005) (finding religious harassment claim could be based on (1) alleged comments by coworker that court characterized as “malicious and vitriolic,” including that all Muslims are terrorists who should be killed, that he wished “all these Muslims were wiped off the face of the earth,” and that plaintiff might get shot for wearing an “Allah” pendant; (2) additional comments questioning plaintiff about what was being taught at her mosque and whether it was “connected with terrorists”; and (3) allegation that plaintiff’s supervisor placed newspaper articles on her desk about mosques in Afghanistan that taught terrorism, along with a note telling her to come into his office and justify such activity).

[166] See *Venters v. City of Delphi*, 123 F.3d 956, 976 (7th Cir. 1997) (holding that employee established comments were unwelcome where she made clear her objection to the comments once she told her supervisor he had “crossed the line”). Complaints to family, friends, or coworkers may also indicate subjective hostility. See, e.g., *Dey v. Colt Constr. & Dev. Co.*, 28 F.3d 1446, 1454 (7th Cir. 1994).

[167] See *Venters*, 123 F.3d at 976.

[168] See *Faragher*, 524 U.S. at 787-88; *Oncale v. Sundowner Offshore Servs.*, 523 U.S. 75, 82-83 (1998) (“The real social impact of workplace behavior often depends on a constellation of surrounding circumstances, expectations, and relationships which are not fully captured by a simple recitation of the words used or the physical acts performed.”); *Harris*, 510 U.S. at 23; see also *EEOC v. Sunbelt Rentals, Inc.*, 521 F.3d 306, 315 (4th Cir. 2008) (evidence that coworkers repeatedly called the employee “Taliban” and “towel head” and made other negative comments related to being a Muslim was enough to overcome summary judgment on both the objective and subjective elements of the severe-or-pervasive test).

[169] *Aulicino v. N.Y.C. Dep’t of Homeless Servs.*, 580 F.3d 73, 83 (2d Cir. 2009).

[170] *Harris*, 510 U.S. at 23.

[171] *Id.*; see also *Rasmy v. Marriott Int’l, Inc.*, 952 F.3d 379, 390 (2d Cir. 2020) (“Although the presence of physical threats or impact on job performance are relevant to finding a hostile work environment, their absence is by no means dispositive.”).

[172] See *Johnson v. Spencer Press of Me., Inc.*, 364 F.3d 368 (1st Cir. 2004) (ruling that jury properly found hostile work environment where supervisor repeatedly insulted plaintiff, mocked his religious beliefs, and threatened him with violence); cf. *Sattar v. Motorola, Inc.*, 138 F.3d 1164, 1167 (7th Cir. 1998) (Muslim supervisor barraged former Muslim employee with e-mails containing dire warnings of the divine punishments that awaited those who refuse to follow Islam).

[173] *Harris*, 510 U.S. at 21; *Meritor Sav. Bank, FSB v. Vinson*, 477 U.S. 57, 64 (1986).

[174] *Harris*, 510 U.S. at 22 (“[E]ven without regard to these tangible effects, the very fact that the discriminatory conduct was so severe or pervasive that it created a work environment abusive to employees because of their race, gender, religion, or national origin offends Title VII’s broad rule of workplace equality Certainly Title VII bars conduct that would seriously affect a reasonable person’s psychological well-being, but the statute is not limited to such conduct.”); see also *Dey v. Colt Constr. & Dev. Co.*, 28 F.3d 1446, 1454-55 (7th Cir. 1994) (“[T]he mention in *Harris* of an unreasonable interference with work performance was not intended to penalize the employee who possesses the dedication and fortitude to complete her assigned tasks even in the face of offensive and abusive [conduct] As Justice Scalia separately explained in *Harris*, the test under Title VII ‘is not whether work has

been impaired, but whether working conditions have been discriminatorily altered.”).

[175] See *Harris*, 510 U.S. at 23 (“Whether an environment is ‘hostile’ or ‘abusive’ can be determined only by looking at all the circumstances . . . [N]o single factor is required.”).

[176] *Faragher v. Boca Raton*, 524 U.S. 775, 788 (1998) (citing *Oncale*, 523 U.S. at 80); see also (finding coworker’s conduct did not create a hostile work environment where coworker sang religious songs, quoted religious scripture, preached and spoke about Church and the Bible, referred to plaintiff as the devil an unspecified number of times over a six-month period, and informed plaintiff that she would go to Hell for not believing in Jesus Christ); *Walker v. McCarthy*, 582 F. App’x 6 (D.C. Cir. 2014) (ruling that plaintiff did not state a hostile work environment religion claim based on receipt of an invitation and emails regarding a coworker’s same-sex marriage); *Sheikh v. Indep. Sch. Dist.* 535, No. 00–1896DWFSRN, 2001 WL 1636504 (D. Minn. Oct. 18, 2001) (holding that a Muslim employee who was ostracized by colleagues because he refused to shake hands with female colleagues did not suffer a materially adverse change in the terms and conditions of employment).

[177] Compare *Garcimonde-Fisher v. Area203 Marketing, LLC*, 105 F. Supp. 3d 825, 838-41 (E.D. Tenn. 2015) (ruling that owner’s cumulative actions may have amounted to “[o]verwhelming pressure to conform to a particular religion or sect,” where he decorated walls with Judeo-Christian artwork, biblical posters and Ten Commandments placards; distributed to employees materials with religious messages and solicitations for donations to overtly religious charities; played Christian movies on breakroom TV all day; employed a staff chaplain who hosted prayer meetings and Bible studies during work; and made comments to one plaintiff that being Catholic was not “the right kind of Christian”), with *Alansari v. Tropic Star Seafood Inc.*, 388 F. App’x 902, 905 (11th Cir. 2010) ([https://1.next.westlaw.com/Link/Document/FullText?findType=Y&serNum=2022583008&pubNum=0006538&originatingDoc=I99411220225211e68cefc52a15cd8e9f&refType=RP&fi=co_pp_sp_6538_905&originatio nContext=document&transitionType=DocumentItem&contextData=\(sc.UserEnteredCitation\)#co_pp_sp_6538_905](https://1.next.westlaw.com/Link/Document/FullText?findType=Y&serNum=2022583008&pubNum=0006538&originatingDoc=I99411220225211e68cefc52a15cd8e9f&refType=RP&fi=co_pp_sp_6538_905&originatio nContext=document&transitionType=DocumentItem&contextData=(sc.UserEnteredCitation)#co_pp_sp_6538_905)) (per curiam) (finding that solicitations to go to church because “Jesus would save” plaintiff, other comments about the plaintiff’s Muslim religion, and the playing of Christian music on the radio did not amount to hostile work environment), *DeFietas v. Horizon Inv. & Mgmt. Corp.*, No. 2:06-cv-926, 2008 WL 204473, at *6 (D. Utah Jan. 24, 2008).

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(“Sporadic invitations to attend church with a coworker, while uncomfortable, do not constitute a hostile work environment.”), *aff’d in part and rev’d in part on other grounds*, 577 F.3d 1151 (10th Cir. 2009), *Marcus v. West*, No. 99 C 0261, 2002 WL 1263999, at *11 (N.D. Ill. June 3, 2002) (finding that asking a very religious employee to swear on a Bible to resolve differences with a colleague and telling her that people did not like her “church lady act” were isolated incidents that were not severe or pervasive enough to create a hostile work environment), *and Sublett v. Edgewood Universal Cabling Sys., Inc.*, 194 F. Supp. 2d 692, 703 (S.D. Ohio 2002) (finding supervisor’s single comment to Rastafarian employee that those “dread things” made him look too “radical” was not sufficiently severe to create a hostile environment).

[178] *Cf. Tessler v. KHOW Radio, Inc.*, No. 95–B–2414, 1997 WL 458489, at *8 (D. Colo. Apr. 21, 1997).

[179] *Cf. Brown v. Polk Cnty.*, 61 F.3d 650, 656–57 (8th Cir. 1995) (en banc) (holding that it did not pose an undue hardship for employer to accommodate supervisor’s sporadic and voluntary prayers during workplace meetings).

[180] *See, e.g., EEOC v. Prospect Airport Servs., Inc.*, 621 F.3d 991, 1000 (9th Cir. 2010) (explaining that “[t]he ‘required level of severity or seriousness varies inversely with the pervasiveness or frequency of the conduct’ (alteration in original)); *Pucino v. Verizon Wireless Commc’ns, Inc.*, 618 F.3d 112, 119 (2d Cir. 2010) (“[A] plaintiff need not show that her [work] environment was both severe *and* pervasive; only that it was sufficiently severe *or* sufficiently pervasive, or a sufficient combination of these elements, to have altered her working conditions.”); *Williams v. Gen. Motors Corp.*, 187 F.3d 553, 563 (6th Cir. 1999) (explaining that in determining whether the alleged conduct rises to the level of severe or pervasive, a court should consider the factual “totality of the circumstances,” and that using a “holistic perspective is necessary, keeping in mind that each successive episode has its predecessors, the impact of the separate incidents may accumulate, and the work environment created thereby may exceed the sum of the individual episodes”); *see also, e.g., Shanoff v. Ill. Dep’t of Hum. Servs.*, 258 F.3d 696, 705 (7th Cir. 2001) (six instances of “rather severe” harassment over four months were sufficient to allow a reasonable jury to rule in favor of plaintiff).

[181] See *Hall v. City of Chi.*, 713 F.3d 325, 330 (7th Cir. 2013) (stating that “one extremely serious act of harassment could rise to an actionable level as could a series of less severe acts” (quoting *Haugerud v. Amery Sch. Dist.*, 259 F.3d 678, 693 (7th Cir. 2001)); cf. *Johnson v. Spencer Press of Me., Inc.*, 364 F.3d 368 (1st Cir. 2004) (in affirming the jury verdict for plaintiff on a religious harassment claim, court noted plaintiff’s testimony that a supervisor who made ongoing derogatory remarks about plaintiff’s religion also once put the point of a knife under plaintiff’s chin, in addition to threatening to kill him with a hand grenade, run him over with a car, and shoot him with a bow and arrow)).

[182] *Ayissi-Etoh v. Fannie Mae*, 712 F.3d 572, 580 (D.C. Cir. 2013) (Kavanaugh, J., concurring) (“As several courts have recognized, . . . a single *verbal* (or visual) incident can . . . be sufficiently severe to justify a finding of a hostile work environment.”).

[183] See *Peters v. Renaissance Hotel Operating Co.*, 307 F.3d 535, 552 (7th Cir. 2002) (holding that the combined impact of the comments directed at the employee and at others was not severe or pervasive enough to create a hostile work environment; “[M]any of the actions that [the employee] identifies were not directed at him As ‘second-hand’ harassment, the impact of these incidents are ‘obviously not as great as the impact of harassment directed at the plaintiff.’” (quoting *Russell v. Bd. of Trs. of Univ. of Ill. at Chi.*, 243 F.3d 336, 343 (7th Cir. 2001))).

[184] See, e.g., *Rasmy v. Marriott Int’l, Inc.*, 952 F.3d 379, 389 & n.44 (2d Cir. 2020) (reaching this conclusion and noting that the EEOC has long taken this position); *Ellis v. Houston*, 742 F.3d 307, 320-21 (8th Cir. 2014) (explaining that when offensive comments not directly made to plaintiff become known to plaintiff, “their relevance to claims of a hostile work environment is clear”); *Reeves v. C.H. Robinson Worldwide, Inc.*, 594 F.3d 798, 811 (11th Cir. 2010) (en banc) (“[W]ords and conduct . . . may state a claim of a hostile work environment, even if the words are not directed specifically at the plaintiff.”); *Williams v. Gen. Motors Corp.*, 187 F.3d 553, 563 (6th Cir. 1999) (overhearing “I’m sick and tired of these fucking women” could be “humiliating and fundamentally offensive to any woman in that work environment”).

[185] Cf. *Hawkins v. PepsiCo, Inc.*, 203 F.3d 274, 276 (4th Cir. 2000) (stating that “a routine difference of opinion” cannot support a hostile work environment claim); *Sunbelt Rentals, Inc.*, 521 F.3d at 315 (4th Cir. 2008) (“[E]ven incidents that would objectively give rise to bruised or wounded feelings will not on that account satisfy

the severe or pervasive standard.”); see also *Chinery v. American Airlines*, 778 F. App’x 142, 145-46 (3d Cir. 2019) (examining whether social media posts about workplace issues and the plaintiff created a hostile work environment, but determined that the conduct was not objectively severe or pervasive). Social media posts that do involve the workplace can become part of a hostile work environment claim. See *Roy v. Correct Care Sols., LLC*, 914 F.3d 52, 63 n.4 (1st Cir. 2019) (“Furthermore, it is not clear at all that Facebook messages should be considered non-workplace conduct where, as here, they were about workplace conduct, including Dever’s reports and rumors, and were sent over social media by an officer who worked in Roy’s workplace.”). In addition, an employee’s wearing religious garb in the workplace, or workplace religious decorations that do not demean or degrade other employees, or their religious views generally, would not, standing alone, constitute a hostile work environment.

[186] See *Faragher v. Boca Raton*, 524 U.S. 775, 802-03 (1998); *Burlington Indus., Inc. v. Ellerth*, 524 U.S. 742, 759-60 (1998).

[187] *Ellerth*, 524 U.S. at 758.

[188] *Faragher*, 524 U.S. at 789-90.

[189] For strict liability to apply to a constructive discharge claim, a supervisor’s tangible employment action must have precipitated the decision to quit. Otherwise, the employer is entitled to raise the affirmative defense described above. See *Pa. State Police v. Suders*, 542 U.S. 129, 146-50 (2004).

[190] *Ellerth*, 524 U.S. at 765; *Faragher*, 524 U.S. at 807.

[191] See, e.g., *Chavez v. Colo. Dep’t of Educ.*, 244 F. Supp. 3d 1106, 1128 (D. Colo. 2017) (ruling that because employer took adequate action to address plaintiff’s complaints that she was being pressured and treated unfairly by her supervisor for refusing to continue attending the supervisor’s Bible study and other church activities, plaintiff could not prevail on harassment claim).

[192] See *Vance v. Ball State Univ.*, 570 U.S. 421, 448-49 (2013) (noting that a complainant can establish employer liability, even when “a harasser is not a supervisor,” “by showing that [the] employer was negligent in failing to prevent harassment from taking place”).

[193] See *Ellerth*, 524 U.S. at 762; *Faragher*, 524 U.S. at 788; *Hafford v. Seidner*, 183 F.3d 506, 513 (6th Cir. 1999); cf. *Guidelines on Discrimination Because of National Origin*, 29 C.F.R. § 1606.8(d) (stating employer is liable for coworker harassment on the basis of national origin when it knew or should have known of the conduct and failed to take immediate and appropriate corrective action); *id.* § 1604.11(e) (sexual harassment).

[194] Cf. *Powell v. Yellow Book USA, Inc.*, 445 F.3d 1074, 1078 (8th Cir. 2006) (finding that employer was not liable for religious harassment of plaintiff because, upon learning of her complaints about a coworker's proselytizing, the employer promptly held a meeting and told the coworker to stop discussing religion matters with plaintiff, and there was evidence that the company continued to monitor the situation to ensure that the coworker did not resume her proselytizing).

[195] Compare *Erickson v. Wisconsin Dep't of Corr.*, 469 F.3d 600, 608 (7th Cir. 2006) (discussing female employee's Title VII action against prison employer based on harassment by male inmates; ruling that "a reasonable jury could have found that, after [the employee's] discussion with her supervisors . . . , [prison] had enough information to make a reasonable employer think there was some probability that [the employee] was being sexually harassed, yet took no remedial action as it was obligated to do under Title VII" (quotation marks and citations omitted)), with *Berry v. Delta Airlines, Inc.*, 260 F.3d 803 (7th Cir. 2001) (finding that employer was not liable for alleged sexual harassment of its female employee by a male contractor because it promptly investigated the allegations, requested a change in the contractor's shift so that he would not have contact with the employee, and asked that all contractors be required to view sexual harassment training video). Cf. *Commission Guidelines*, 29 C.F.R. § 1604.11(e), 1606.8(e).

[196] See *EEOC v. Townley Eng'g & Mfg. Co.*, 859 F.2d 610, 621 (9th Cir. 1988) ("Where the religious practices of employers . . . and employees conflict, Title VII does not, and could not, require individual employers to abandon their religion. Rather, Title VII attempts to reach a mutual accommodation of the conflicting religious practices."); cf. *Burwell v. Hobby Lobby, Stores, Inc.*, 573 U.S. 682, 702 (2014) (rejecting court's holding below that, unlike nonprofit corporations, "for-profit, secular corporations cannot engage in religious exercise") (RFRA).

[197] See *Peterson v. Hewlett-Packard Co.*, 358 F.3d 599, 607 (9th Cir. 2004) ("[A]n employer need not accommodate an employee's religious beliefs if doing so would

result in discrimination against his coworkers or deprive them of contractual or other statutory rights.”).

[198] *Id.*

[199] See *Ervington v. LTD Commodities, LLC*, 555 F. App'x 615, 618 (7th Cir. 2014) (upholding discharge for employee's continuing, after warning, to violate company's anti-harassment policy by distributing religious pamphlets that denigrated other religions); *Bodett v. CoxCom, Inc.*, 366 F.3d 736, 745-46 (9th Cir. 2004) (ruling that supervisor's harassment of subordinate in violation of employer's anti-harassment policy was a legitimate nondiscriminatory reason for termination, even if the violations were motivated by the supervisor's religious beliefs).

[200] *Smith v. City of Phila.*, 285 F. Supp. 3d 846, 854 (E.D. Pa. 2018).

[201] See *Cloutier v. Costco Wholesale Corp.*, 390 F.3d 126, 133 (1st Cir. 2004) (“Under Title VII, an employer must offer a reasonable accommodation to resolve a conflict between an employee's sincerely held religious belief and a condition of employment, unless such an accommodation would create an undue hardship for the employer's business.”); *Weathers v. FedEx Corp. Servs., Inc.*, No. 09 C 5493, 2011 WL 5184406, at *11 (N.D. Ill. Nov. 1, 2011) (ruling that employee's request for clarification of an employer “letter of counseling” instructing that his discussions of religion with coworkers “must cease” was a request for accommodation, and holding that an ongoing broad instruction not to discuss religion could be found to be an adverse action, because it left him “unable to exercise his religious belief and unable to discuss a subject of broad scope and of great importance to him” even if the conversation was initiated by others).

[202] Cf. *EEOC v. Abercrombie & Fitch Stores, Inc.*, 135 S. Ct. 2028, 2034 (2015) (“Title VII does not demand mere neutrality with regard to religious practices – that they be treated no worse than other practices. Rather, it gives them favored treatment, affirmatively obligating employers not ‘to fail or refuse to hire or discharge any individual. . . because of such individual’s’ ‘religious observance and practice.’” (alteration in original)).

[203] 42 U.S.C. § 2000e(j); *Commission Guidelines*, 29 C.F.R. § 1605.2(b).

[204] Compare *Trans World Airlines, Inc. v. Hardison*, 432 U.S. 63, 84 (1977) (interpreting Title VII “undue hardship” standard), with 42 U.S.C. § 12111(10)(A) (defining ADA “undue hardship” standard). See *infra* § 12-IV-B.

[205] *Abercrombie & Fitch Stores, Inc.*, 135 S. Ct. at 2034.

[206] See *id.* (“An employer is surely entitled to have, for example, a no-headwear policy as an ordinary matter. But when an applicant requires an accommodation as an ‘aspec[t] of religious . . . practice,’ it is no response that the subsequent ‘fail[ure] . . . to hire’ was due to an otherwise-neutral policy.” (alterations in original)).

[207] *Protos v. Volkswagen of Am., Inc.*, 797 F.2d 129, 136 (3d Cir. 1986) (citation omitted); see also *id.* (“This is . . . part of our ‘happy tradition’ of avoiding unnecessary clashes with the dictates of conscience.”) (citation omitted); cf. *Hobbie v. Unemployment Appeals Comm’n of Fla.*, 480 U.S. 136, 146 (1987) (explaining that, under the Free Exercise Clause of the First Amendment, the government “may not force an employee ‘to choose between following the precepts of her religion and forfeiting benefits, . . . and abandoning one of the precepts of her religion in order to accept work’” (citation omitted) (alteration in original)).

[208] *Hardison*, 432 U.S. at 84.

[209] Furthermore, if companies are interested in expressing their views on social issues and having their employees convey the company’s views, the issue of religious accommodation could arise to the extent an employee believes that a message the employer would like the employee to convey violates the employee’s religious beliefs. For example, if a company has a policy that all employees in its retail stores must wear shirts conveying messages celebrating LGBTQ Pride in the month of June, or that requires employees to say “Jesus is our Savior” when answering the phone during the Christmas season, the company may have an obligation to accommodate employees who cannot convey these messages because of religious beliefs.

[210] See *Ansonia Bd. of Educ. v. Philbrook*, 479 U.S. 60, 68 (1980) (“The employer violates the statute unless it ‘demonstrates that [it] is unable to reasonably accommodate . . . an employee’s . . . religious observance or practice without undue hardship on the conduct of the employer’s business.’”); *Hardison*, 432 U.S. at 74 (“[T]he employer’s statutory obligation to make reasonable accommodation for the religious observances of its employees, short of incurring an undue hardship, is clear.”); cf. *Abercrombie & Fitch Stores, Inc.*, 135 S. Ct. at 2033-34 (“[R]eligious practice is one of the protected characteristics that cannot be accorded disparate treatment and must be accommodated.”).

[211] See 42 U.S.C. § 2000e-2(a)(1) (making it unlawful “to discriminate against any individual with respect to his. . . terms, conditions, or privileges of employment, because of such individual’s . . . religion”).

[212] *Compare Storey v. Burns Int’l Sec. Servs.*, 390 F.3d 760, 765 (3d Cir. 2004) (“An employer’s failure to reasonably accommodate an employee’s sincerely held religious belief that conflicts with a job requirement can also amount to an adverse employment action unless the employer can demonstrate that such an accommodation would result in ‘undue hardship.’”), *EEOC v. Townley Eng’g & Mfg. Co.*, 859 F.2d 610, 614 n.5 (9th Cir. 1988) (“The threat of discharge (or other adverse employment practices) is a sufficient penalty. An employee does not cease to be discriminated against because he temporarily gives up his religious practice and submits to the employment policy.” (internal citation omitted)), and *Rodriguez v. City of Chi.*, No. 95-C-5371, 1996 WL 22964, at *3 (N.D. Ill. Jan. 12, 1986) (“It is nonsensical to suggest that an employee who, when forced by his employer to choose between his job and his faith, elects to avoid potential financial and/or professional damage by acceding to his employer’s religiously objectionable demands has not been the victim of religious discrimination.”), with *Brooks v. City of Utica*, 275 F. Supp. 3d 370, 378 (N.D.N.Y. 2017) (“[U]nrealized threats do not constitute adverse employment actions.”). See generally *Reed v. UAW*, 569 F.3d 576, 580 (6th Cir. 2009) (stating that because plaintiff has not shown any material adverse action, his reasonable accommodation claim fails, however, “an employee who believes that he is being treated less favorably because of his religion or some other protected ground has the right to bring a disparate treatment claim.”); *Mohammed v. Schneider Nat’l Carriers, Inc.*, No. 18-0642, 2018 WL 5634897, at *2-4 (W.D. Pa. Oct. 12, 2018) (magistrate judge report and recommendation) (reviewing cases), *adopted*, 2018 WL 5633994 (W.D. Pa. Oct. 31, 2018).

[213] See *Chalmers v. Tulon Co. of Richmond*, 101 F.3d 1012, 1019 (4th Cir. 1996) (“[A] prima facie case under the accommodation theory requires evidence that [the employee] informed her employer that her religious needs conflicted with an employment requirement and asked the employer to accommodate her religious needs.”); *Redmond v. GAF Corp.*, 574 F.2d 897, 901 (7th Cir. 1978) (“Implicit within plaintiff’s prima facie case is the requirement that plaintiff inform his employer of both his religious needs and his need for an accommodation.”).

[214] See, e.g., *Dixon v. Hallmark Cos.*, 627 F.3d 849, 856 (11th Cir. 2010) (holding that employer was incorrect in arguing that employees’ accommodation claim failed because they did not expressly tell employer that they did not want to take

down religious artwork because of their religion, reasoning that evidence of the employer's awareness of the tension between its order to remove the artwork and the employees' religious beliefs was sufficient to establish notice); *Brown v. Polk Cnty.*, 61 F.3d 650, 654 (8th Cir. 1995) (en banc) (where plaintiff alleged that he was terminated based on his known religious activities, court held that employer had obligation to accommodate absent undue hardship even though plaintiff had never explicitly asked for a religious accommodation because employer's "first reprimand related directly to religious activities by" plaintiff); *id.* ("An employer need have only enough information about an employee's religious needs to permit the employer to understand the existence of a conflict between the employee's religious practices and the employer's job requirements." (internal quotation marks and citation omitted)); *Hellinger v. Eckerd Corp.*, 67 F. Supp. 2d 1359, 1363-64 (S.D. Fla. 1999) (ruling that notice was sufficient where employer learned of applicant's religious objection to a particular practice when he contacted applicant's former supervisor for a reference).

[215] See *supra* note 210.

[216] *Abercrombie & Fitch Stores, Inc.*, 135 S. Ct. at 2033-34 (holding that decision not to hire Muslim applicant because of assumed conflict between headscarf and company "Look Policy" violated Title VII's prohibition that actions are not taken "with the *motive* of avoiding the need for accommodating a religious practice").

[217] See *Xodus v. Wackenhut Corp.*, 619 F.3d 683, 686-87 (7th Cir. 2010) (finding that district court did not clearly err in determining that employee had failed to put employer on sufficient notice because he only referenced his "beliefs" but did not say they were religious); *Heller v. EBB Auto Co.*, 8 F.3d 1433, 1439 (9th Cir. 1993) (employee's request for leave to participate in his wife's religious conversion ceremony was sufficient to place employer on notice that this was pursuant to a religious practice or belief; an employer need have "only enough information about an employee's religious needs to permit the employer to understand the existence of a conflict between the employee's religious practices and the employer's job requirements").

[218] Cf. *LaFevers v. Saffle*, 936 F.2d 1117 (10th Cir. 1991) (holding that although not all Seventh-day Adventists are vegetarian, an individual adherent's genuine religious belief in such a dietary practice warrants constitutional protection under the First Amendment); see *Seshadri v. Kasraian*, 130 F.3d 798, 800 (7th Cir. 1997) (holding that employee who seeks accommodation need not belong to an

established church, “but a person who seeks to obtain a privileged legal status by virtue of his religion cannot preclude inquiry designed to determine whether he has in fact a religion”); *Chrysler Corp. v. Mann*, 561 F.2d 1282, 1285 (8th Cir. 1977) (observing that the plaintiff “did little to acquaint Chrysler with his religion and its potential impact upon his ability to perform his job”); see also *Redmond*, 574 F.2d at 902 (noting that “an employee who is disinterested in informing his employer of his religious needs ‘may forego the right to have his beliefs accommodated by his employer’” (citation omitted)).

[219] See, e.g., *Toronka v. Cont’l Airlines, Inc.*, 649 F. Supp. 2d 608, 611-12 (S.D. Tex. 2009) (holding in Title VII case that a moral and ethical belief in the power of dreams that is based on religious convictions and traditions of African descent is a religious belief, and that this determination does not turn on veracity but rather is based on a theory of “‘man’s nature or his place in the Universe,’” even if considered by others to be “eccentric” (quoting *Brown v. Dade Christian Schs., Inc.*, 556 F.2d 310, 324 (5th Cir. 1977) (Roney, J., dissenting); *Cooper v. Gen. Dynamics*, 533 F.2d 163, 168-69 (5th Cir. 1976))); cf. *Church of Lukumi Babalu Aye, Inc. v. City of Hialeah*, 508 U.S. 520, 531 (1993) (holding that although animal sacrifice may seem “abhorrent” to some, Santeria is religious in nature and is protected by the First Amendment); *Thomas v. Rev. Bd. of Ind. Emp’t Sec. Div.*, 450 U.S. 707, 714 (1981) (ruling that “religious beliefs need not be acceptable, logical, consistent, or comprehensible to others in order to merit First Amendment protection”); *United States v. Meyers*, 906 F. Supp. 1494, 1499 (D. Wyo. 1995) (relying on First Amendment jurisprudence to observe in Religious Freedom Restoration Act case that “one man’s religion will always be another man’s heresy”).

[220] See *Cary v. Carmichael*, 908 F. Supp. 1334, 1344 (E.D. Va. 1995) (holding no religious discrimination where employee failed to give employer proper notice so that it could attempt an accommodation of his religious objection to signing consent form for a drug test), *aff’d sub nom*, 116 F.3d 472 (4th Cir. 1997) (unpublished table decision); see also *Elmenayer v. ABF Freight Sys.*, No. 98-CV-4061 (JG), 2001 WL 1152815, at *5 (E.D.N.Y. Sept. 20, 2001) (holding that employer was not liable for disciplining an employee for tardiness where the employee failed – until after his discharge – to explain that tardiness was because he attended a prayer service), *aff’d on other grounds*, 318 F.3d 130 (2d Cir. 2003).

[221] Notwithstanding the different legal standards for determining when a failure to accommodate poses an undue hardship under Title VII and the ADA, see *supra* notes 5 and 6, courts have endorsed a cooperative information-sharing process

between employer and employee for religious accommodation requests, similar to the “interactive process” used for disability accommodation requests under the ADA. See *Ansonia Bd. of Educ. v. Philbrook*, 479 U.S. 60, 69 (1986) (explaining that “bilateral cooperation is appropriate in the search for an acceptable reconciliation of the needs of the employee’s religion and the exigencies of the employer’s business.” (internal quotation marks and citation omitted)); see also *Thomas v. Nat’l Ass’n of Letter Carriers*, 225 F.3d 1149, 1155 n.5 (10th Cir. 2000) (stating that “[t]he [ADA] ‘interactive process’ rationale is equally applicable to the obligation to offer a reasonable accommodation to an individual whose religious beliefs conflict with an employment requirement”).

[222] See, e.g., *EEOC v. Arlington Transit Mix, Inc.*, 957 F.2d 219, 222 (6th Cir. 1991) (“After failing to pursue [a voluntary waiver of seniority rights] or any other reasonable accommodation, the company is in no position to argue that it was unable to accommodate reasonably [plaintiff’s] religious needs without undue hardship on the conduct of its business.”); *EEOC v. Ithaca Indus., Inc.*, 849 F.2d 116, 118-19 (4th Cir. 1988) (finding that employer’s failure to attempt to accommodate, absent any showing of undue hardship, violated Title VII).

[223] *Ansonia Bd. of Educ.*, 479 U.S. at 68-69 (holding that an employer could satisfy its obligation by offering an alternative reasonable accommodation to the particular one proposed by the employee); *Brener v. Diagnostic Ctr. Hosp.*, 671 F.2d 141, 146 (5th Cir. 1982) (explaining that an “employee has a correlative duty to make a good faith attempt to satisfy his needs through means offered by the employer” and that a “reasonable accommodation need not be on the employee’s terms only” before concluding that the employee failed to fully explore shift swaps proposed by his employer); *Chrysler Corp. v. Mann*, 561 F.2d 1282, 1286 (8th Cir. 1977) (where employee “will not attempt to accommodate his own beliefs through the means already available to him or cooperate with his employer in its conciliatory efforts, he may forego the right to have his beliefs accommodated”).

[224] See *supra* §§ 12-I-A-2 (“Sincerely Held”), 12-I-A-3 (“Employer Inquiries into Religious Nature or Sincerity of Belief”); see also *Adeyeye v. Heartland Sweeteners, LLC*, 721 F.3d 444, 451 (7th Cir. 2013) (“If the managers who considered the request had questions about whether the request was religious, nothing would have prevented them from asking [the employee] to explain a little more about the nature of his request . . . [The] law leaves ample room for dialogue on these matters.”); *Vinning-El v. Evans*, 657 F.3d 591, 594 (7th Cir. 2011) (noting, in a prison religious accommodation case, that where asserted religious belief differed

significantly “from the orthodox beliefs of [prisoner’s] faith, . . . [s]uch a belief isn’t impossible, but it is sufficiently rare that a prison’s chaplain could be skeptical and conduct an inquiry to determine whether the claim was nonetheless sincere”); *Dockery v. Maryville Acad.*, 379 F. Supp. 3d 704, 718-19 (N.D. Ill. 2019) (holding that employer had objective basis for questioning whether employee sincerely believed that it was against his religion to work during Sabbath, where employee previously was willing to do so, employee himself testified that he told employer he could not work on Friday and Saturdays “because he was ‘used to’ and ‘accustomed to’ having those days off ‘to be able to worship with [his] family and do different things with [his] family,’” and employee failed to explain or provide more information to employer as requested).

[225] See *Bushouse v. Loc. Union 2209*, 164 F. Supp. 2d 1066, 1078 & n.18 (N.D. Ind. 2001) (holding that union’s refusal to provide accommodation unless employee produced independent corroboration that his accommodation request was motivated by a sincerely held religious belief did not violate Title VII’s religious accommodation provision, but cautioning that the holding was limited to “the facts and circumstances of the present case” and that “[t]he inquiry [into sincerity] and the scope of that inquiry will necessarily vary based upon the individual requesting corroboration and the facts and circumstances of the request”).

[226] See *United States v. Broyles*, 423 F.2d 1299, 1302 (4th Cir. 1970) (letter from retired Army officer who had known conscientious objector for more than twenty years, and letter from college president who had known him for more than ten years, were “[i]mpressive backing” for his claims of sincere religious belief).

[227] See *Ansonia Bd. of Educ.*, 479 U.S. at 70 (referring to reasonable accommodation as one that “eliminates the conflict between employment requirements and religious practices”); see also, e.g., *EEOC v. Ilona of Hungary, Inc.*, 108 F.3d 1569 (7th Cir. 1997) (ruling that employer did not satisfy reasonable accommodation requirement by offering to let Jewish employees take off a day other than Yom Kippur, because that would not eliminate the conflict between religion and work); *Opuku-Boateng v. California*, 95 F.3d 1461, 1467 (9th Cir. 1996) (if negotiations between employer and employee “do not produce a proposal by the employer that would eliminate the religious conflict, the employer must either accept the employee’s proposal or demonstrate that it would cause undue hardship were it to do so”); *Cooper v. Oak Rubber Co.*, 15 F.3d 1375, 1378 (6th Cir. 1994) (“If the employer’s efforts fail to eliminate the employee’s religious conflict, the burden remains on the employer to establish that it is unable to reasonably accommodate

the employee's beliefs without incurring undue hardship."); *EEOC v. Universal Mfg. Corp.*, 914 F.2d 71, 72 (5th Cir. 1990) (per curiam) (district court "erred in ruling that, absent a showing of undue hardship by an employer, accommodating only one of the two practices of the employee's religion, both of which conflicted with the employee's work duties, satisfied as a matter of law the duty of 'reasonable accommodation'"); *Baker v. Home Depot*, 445 F.3d 541, 547-48 (2d Cir. 2006) ("[T]he shift change offered to Baker was no accommodation at all because, although it would allow him to attend morning church services, it would not permit him to observe his religious requirement to abstain from work *totally* on Sundays."); cf. *US Airways, Inc. v. Barnett*, 535 U.S. 391, 400 (2002) (in context of Americans with Disabilities Act, "the word 'accommodation' . . . conveys the need for effectiveness").

Some courts of appeals have appeared to suggest that a reasonable accommodation need only lessen the conflict between religion and work, even in the absence of a showing that other accommodations would impose undue hardship. But, in practice, even those courts have not applied a standard that is materially different from the one described above, and they take into account facts that the Commission and other courts would analyze as relevant only to undue hardship. See, e.g., *EEOC v. Firestone Fibers & Textiles Co.*, 515 F.3d 307 (4th Cir. 2008) (analyzing reasonableness of proposed accommodation based in part on facts typically considered as part of undue hardship analysis); *Sturgill v. United Parcel Serv., Inc.*, 512 F.3d 1024, 1030-33 (8th Cir. 2008) (rejecting jury instruction that described a reasonable accommodation as one must eliminate any work-religion conflict because "[w]hat is reasonable depends on the totality of the circumstances and therefore might, or might not, require elimination of a particular, fact-specific conflict"). The Commission believes its approach to this issue is straightforward and in keeping with the purpose of Title VII's accommodation requirement. Concerns about issues such as conflicts with a union contract or burdens on other employees' settled expectations can and should be addressed in the context of evaluating whether an accommodation would impose an undue hardship. Moreover, the employer need not grant an employee's requested accommodation if the employer wishes instead to offer an alternative reasonable accommodation of its own choosing that also would eliminate the work-religion conflict and would not adversely affect the employee's terms, conditions, or privileges of employment.

[228] See, e.g., *Knight v. Conn. Dep't of Pub. Health*, 275 F.3d 156, 168 (2d Cir. 2001) (holding that employer complied with Title VII when it granted partial accommodation—allowing proselytizing at certain times, not at all times, as

requested—where employer could not allow additional proselytizing without “jeopardiz[ing] the state’s ability to provide services in a religion-neutral manner,” which the court apparently concluded would pose an undue hardship); *Ilona of Hungary, Inc.*, 108 F.3d at 1576 (suggesting that if employer would suffer undue hardship from eliminating a religious conflict by granting a full day of leave to observe a religious holiday, the employer should still “offer a partial day off”);

[229] See *Ansonia Bd. of Educ.*, 479 U.S. at 70 (explaining that the accommodation of unpaid leave generally has “no direct effect upon either employment opportunities or job status” in the course of concluding that it would generally be reasonable, but emphasizing that “unpaid leave is not a reasonable accommodation when paid leave is provided for all purposes except religious ones” (first emphasis added) (internal quotation marks and citation omitted)); *Adeyeye*, 721 F.3d at 455 (not a reasonable accommodation to offer “voluntary self-termination with the possibility of being rehired”); *Cosme v. Henderson*, 287 F.3d 152, 160 (2d Cir. 2002) (stating that “an accommodation might be unreasonable if it imposes a significant work-related burden on the employee without justification”); *Wright v. Runyon*, 2 F.3d 214, 217 (7th Cir. 1993) (explaining that the question whether an accommodation is reasonable requires a “more searching inquiry” if an employee, “in order to accommodate his religious practices, had to accept a reduction in pay or some other loss of benefits”); *Am. Postal Workers Union v. Postmaster Gen.*, 781 F.2d 772, 776-77 (9th Cir. 1986) (holding employers must offer accommodations that “reasonably preserve th[e] employee’s . . . compensation, terms, conditions, or privileges of employment”); *Draper v. U.S. Pipe & Foundry Co.*, 527 F.2d 515, 519-20 (6th Cir. 1975) (ruling that where a transfer would adversely affect employee because, *inter alia*, it would involve a substantial reduction in pay, employer “first must attempt to accommodate the employee within his current job classification,” and transfer may be considered “as a last resort” only if “no such accommodation is possible, or if it would impose an undue hardship upon the employer”); see also *Commission Guidelines*, 29 C.F.R. § 1605.2(c)(2)(ii) (“[W]hen there is more than one means of accommodation which would not cause undue hardship, the employer or labor organization must offer the alternative which least disadvantages the individual with respect to his or her employment opportunities.”).

[230] See *Ansonia Bd. of Educ.*, 479 U.S. at 68 (“[W]here the employer has already reasonably accommodated the employee’s religious needs, the statutory inquiry is at an end. The employer need not further show that each of the employee’s alternative accommodations would result in undue hardship.”); *Rodriguez v. City of Chi.*, 156 F.3d 771, 776 (7th Cir. 1998) (employee is not entitled to his choice of

reasonable accommodation); *Smith v. Pyro Mining Co.*, 827 F.2d 1081, 1085 (6th Cir. 1987) (same); *cf. Opuku-Boateng*, 95 F.3d at 1475 (ruling that employer violated Title VII because it offered no accommodation, such as employee's suggestions of scheduling him instead for other equally undesirable shifts, and employer did not show undue hardship).

[231] See *Ansonia Bd. of Educ.*, 479 U.S. at 70-71 (“unpaid leave is not a reasonable accommodation when paid leave is provided for all purposes *except* religious ones . . . [because] [s]uch an arrangement would display a discrimination against religious practices that is the antithesis of reasonableness”). In cases involving requests for leave as an accommodation, an employer does not have to provide paid leave as an accommodation beyond that otherwise available to the employee but may have to provide unpaid leave as an accommodation if doing so would not pose an undue hardship.

[232] See *Commission Guidelines*, 29 C.F.R. § 1605.2(c)(2)(ii) (“[W]hen there is more than one means of accommodation which would not cause undue hardship, the employer or labor organization must offer the alternative which least disadvantages the individual with respect to his or her employment opportunities.”). This principle is consistent with the Supreme Court’s holding in *Ansonia Board of Education* that an employer discharges its accommodation obligation by offering *any* accommodation that is reasonable. 479 U.S. at 68-69. In reaching this conclusion, the Court observed that the EEOC guideline calling for employers to offer the accommodation that least disadvantages an individual’s employment opportunities (without undue hardship) is different from requiring an “employer to accept any alternative favored by the employee short of undue hardship.” See *id.* at 69 n.6 (referring to 29 C.F.R. § 1605.2(c)(2)(ii)). The Court emphasized that the guideline “contains a significant limitation,” calling for comparative analysis of accommodations only when an accommodation offered by an employer disadvantages employment opportunities. *Id.* In the wake of *Ansonia*, many courts have, consistent with the Commission’s guidelines, evaluated whether employer accommodations had a negative impact on the individual’s employment opportunities as part of the analysis into whether the accommodations were “reasonable.” See *supra* note 229 (citing cases).

[233] *Pyro Mining Co.*, 827 F.2d at 1085 (quoting *Redmond v. GAF Corp.*, 574 F.2d 897, 902-03 (7th Cir. 1978)).

[234] *Cf. Baker v. Home Depot*, 445 F.3d 541, 547-48 (2d Cir. 2006) (finding that employer's offer to schedule employee to work in the afternoon or evenings on Sundays, rather than the mornings, was not a "reasonable" accommodation under Title VII where employee's religious views required not only attending Sunday church services but also refraining from work on Sundays).

[235] *See Ansonia*, 479 U.S. at 69 (employer is not required to offer employee's preferred reasonable accommodation); *Porter v. City of Chi.*, 700 F.3d 944, 951 (7th Cir. 2012) (same).

[236] *See infra* note 278.

[237] *See Shelton v. Univ. of Med. & Dentistry of N.J.*, 223 F.3d 220, 226 (3d Cir. 2000) (finding that state hospital's offer to transfer nurse laterally to newborn intensive care unit was reasonable accommodation for her religious beliefs which prevented her from assisting in emergency abortions of live fetuses," where hospital had staffing cuts and concerns about risks to patients' safety and nurse presented no evidence that transfer would affect her salary or benefits); *see also Rodriguez v. City of Chi.*, 156 F.3d 771, 774 (7th Cir. 1998) (holding that city's offer to allow police officer to exercise his right under collective bargaining agreement to transfer to a district with no abortion clinics, which would resolve his religious objection to being assigned to guard such facilities and would result in "no reduction in pay or benefits," was a reasonable accommodation and observing that Title VII did not compel the employer to grant the officer's preferred accommodation of remaining in his district but being relieved of such assignments); *Wright v. Runyon*, 2 F.3d 214, 217 (7th Cir. 1993) (finding that employer reasonably accommodated employee by suggesting he exercise his rights under collective bargaining agreement to bid on jobs that he would have been entitled to, that were "essentially equivalent" to his current position, and that would have eliminated the conflict between work and religion).

[238] Federal conscience laws provide protections related to abortion and sterilization and include the Church Amendments (42 U.S.C. § 300a-7 et seq.), the Coats-Snowe Amendment (Section 245 of the Public Health Service Act, 42 U.S.C. § 238n), the Weldon Amendment (part of every HHS appropriations act since 2005), and Section 1553 of the Affordable Care Act (42 U.S.C. § 18113). These laws are enforced by the Department of Health and Human Services (HHS). For example, in 2019, HHS found that a university hospital violated the Church Amendments by discriminating against health care personnel who have religious or moral objections

to participating in abortions when it scheduled and pressured them to assist with elective abortions despite specific and repeated requests not to be assigned to those procedures due to religious and moral objections. See Letter from Roger T. Severino, Dir., Off. of Civ. Rts., Dep't of Health & Hum. Svcs. & Luis E. Perez, Deputy Dir., Off. of Civ. Rts., Dep't of Health & Hum. Svcs. (Aug. 28, 2019), (finding that the University of Vermont Medical Center unlawfully forced health care personnel, including nurses, to assist in abortions),

https://www.hhs.gov/sites/default/files/uvmmc-nov-letter_508.pdf

(https://www.hhs.gov/sites/default/files/uvmmc-nov-letter_508.pdf). The Commission is referencing these laws for informational purposes and is not opining on any of their requirements or whether they would require additional burdens on employers beyond Title VII's analysis for reasonable accommodation.

[239] *Lawson v. Washington*, 296 F.3d 799, 805 n.5 (9th Cir. 2002).

[240] See *supra* notes 210-212 and accompanying text.

[241] See *Cooper v. Oak Rubber Co.*, 15 F.3d 1375, 1379 (6th Cir. 1994) (holding that employer was obligated to accommodate a Seventh-day Adventist employee whose need for accommodation to observe Sabbath had changed in the 17 months since employer had last scheduled her to work on a Friday night or Saturday, where her “undisputed testimony was that her faith and commitment to her religion grew during this time”).

[242] *Trans World Airlines, Inc. v. Hardison*, 432 U.S. 63, 84 (1977). The “more than a *de minimis* cost” Title VII undue hardship standard is lower than the ADA undue hardship standard, which requires employers to show that the accommodation would cause “significant difficulty or expense,” 42 U.S.C. § 12111(10)(A).

[243] The statute, at 42 U.S.C. § 2000e(j), and the *Commission Guidelines*, at 29 C.F.R. § 1605.2(b), require an employer to reasonably accommodate an employee's or applicant's religious beliefs and practices unless the “employer demonstrates” that doing so would pose an undue hardship. Even when courts have focused on reasonableness before looking at undue hardship, the employer still has the burden of persuasion on the undue hardship issue. See, e.g., *EEOC v. Firestone Fibers & Textiles Co.*, 515 F.3d 307, 315 (4th Cir. 2008); *Sturgill v. United Parcel Serv., Inc.*, 512 F.3d 1024, 1033 n.4 (8th Cir. 2008).

[244] *Tooley v. Martin-Marietta Corp.*, 648 F.2d 1239, 1243 (9th Cir. 1981) (internal quotation marks and citation omitted).

[245] See *Commission Guidelines*, 29 C.F.R. § 1605.2(e).

[246] Compare *Cooper*, 15 F.3d at 1380 (finding that employee's request not to be scheduled for Saturday work due to Sabbath observance posed undue hardship for employer because it would have required either hiring an additional worker or risking the loss of production), and *Beadle v. Tampa*, 42 F.3d 633, 637-38 (11th Cir. 1995) (finding that requiring police department to alter training program schedule to accommodate employee's religious needs amounted to more than *de minimis* cost and thus an undue hardship because employee "would not have experienced the educational benefits of working with different training officers"), with *Protos v. Volkswagen of Am., Inc.*, 797 F.2d 129, 133-34 (3d Cir. 1986) (finding that employee's request not to be scheduled for Saturday work due to Sabbath observance did not pose undue hardship where district court found that that efficiency, production, and quality would be not affected and entire assembly line remained intact notwithstanding employee's Saturday absences).

[247] See *Tabura v. Kellogg USA*, 880 F.3d 544, 558 (10th Cir. 2018) (reversing summary judgment for employer where it "did not . . . cite to any evidence to support its assertions" that accommodating plaintiffs' need to observe their Sabbath would impose an undue hardship "in the form of unauthorized overtime, quality control issues, and even forcing entire lines to shut down"); *Brown v. Gen. Motors Corp.*, 601 F.2d 956, 960 (8th Cir. 1979) (holding that "projected 'theoretical' future effects cannot outweigh the undisputed fact that no monetary costs and *de minimis* efficiency problems were actually incurred during the three month period in which [employee] was accommodated"); *Tooley v. Martin-Marietta Corp.*, 648 F.2d 1239, 1243 (9th Cir. 1981) (undue hardship requires "proof of actual imposition on coworkers or disruption of the work routine" rather than "conceivable or hypothetical hardships" (internal quotation marks and citation omitted)); *Toledo v. Nobel-Sysco, Inc.*, 892 F.2d 1481, 1492 (10th Cir. 1989) ("Any proffered hardship . . . must be actual," not speculative).

[248] *Trans World Airlines, Inc. v. Hardison*, 432 U.S. 63, 84 (1977); see also *Commission Guidelines*, 29 C.F.R. § 1605.2(e)(1).

[249] *EEOC v. Townley Eng'g & Mfg. Co.*, 859 F.2d 610, 616 (9th Cir. 1988) (quoting *Anderson v. Gen. Dynamic*, 589 F.2d 397, 402 (9th Cir. 1978)) (alteration in original).

[250] *Commission Guidelines*, 29 C.F.R. § 1605.2(e)(1).

[251] *Id.* For example, in *Hardison*, the payment of overtime (or premium pay) to another employee so that plaintiff could be off for weekly religious observance was an undue hardship. 432 U.S. at 68-69, 84. By contrast, infrequent payment of premium wages for an occasional religious observance is not “more than *de minimis*.” See, e.g., *EEOC v. Sw. Bell Tel. LP*, No. 3:06CV00176 JLH, 2007 WL 2891379, at *4 (E.D. Ark. Oct. 3, 2007) (denying summary judgment for employer on claim by two employees that they were improperly denied leave for annual religious observance that would have required company to pay overtime wages of approximately \$220 each to two replacements, where facility routinely paid technicians overtime, employer failed to contact union about possible accommodation, and policy providing for only one technician on leave per day was not always observed, and there was no evidence that customer service needs actually went unmet on day at issue) (jury verdict for plaintiffs subsequently entered), *appeal dismissed*, 550 F.3d 704 (8th Cir. 2008); see also *Redmond v. GAF Corp.*, 574 F.2d 897, 904 (7th Cir. 1987) (ruling that employer could not demonstrate that paying replacement worker premium wages would cause undue hardship because plaintiff would have been paid premium wages for hours at issue).

[252] See, e.g., *Brown v. Polk Cnty.*, 61 F.3d 650, 655 (8th Cir. 1995) (en banc) (holding that allowing employee to assign secretary to type his Bible study notes posed more than *de minimis* cost because secretary would otherwise have been performing employer’s work during that time); see also *Protos v. Volkswagen of Am., Inc.*, 797 F.2d 129, 134-35 (3d Cir. 1986) (no undue hardship where “efficiency, production, quality and morale ... remained intact during [employee’s] absence”).

[253] See *Peterson v. Hewlett-Packard Co.*, 358 F.3d 599, 607 (9th Cir. 2004) (“[A]n employer need not accommodate an employee’s religious beliefs if doing so would result in discrimination against his coworkers or deprive them of contractual or other statutory rights.”); *Virts v. Consol. Freightways Corp. of Del.*, 285 F.3d 508, 517-18 (6th Cir. 2002) (holding that trucking firm had no obligation under Title VII to accommodate a driver’s religious request for only male driving partners, where making assignments in this manner would have violated collective bargaining agreement).

[254] See, e.g., *EEOC v. GEO Grp., Inc.*, 616 F.3d 265, 273 (3d Cir. 2010) (“A religious accommodation that creates a genuine safety or security risk can undoubtedly constitute an undue hardship for an employer-prison.”). However, an employer should not assume that it would pose an undue hardship to accommodate a religious practice that appears to conflict with a generally applicable safety

requirement, but rather should assess whether an undue hardship is actually posed. For example, there are existing religious exemptions to the government enforcement procedures of some safety requirements. See, e.g., Occupational Safety & Health Admin., U.S. Dep't of Lab., STD 1-6.5: Exemption for Religious Reason from Wearing Hard Hats (June 20, 1994),

<https://www.osha.gov/enforcement/directives/std-01-06-005>

(<https://www.osha.gov/enforcement/directives/std-01-06-005>) (exempting employers from citations for certain violations based on religious objection of employee, but providing for various reporting requirements).

[255] See, e.g., *Bruff v. N. Miss. Health Serv., Inc.*, 244 F.3d 495, 501 (5th Cir. 2001) (requiring coworkers of plaintiff mental health counselor to assume disproportionate workload to accommodate plaintiff's request not to counsel certain clients on religious grounds would involve more than *de minimis* cost); *Bhatia v. Chevron USA, Inc.*, 734 F.2d 1382, 1384 (9th Cir. 1984) (per curiam) (holding that it would be undue hardship to reassign plaintiff's share of potentially hazardous work to coworkers); *EEOC v. BJ Servs. Co.*, 921 F. Supp. 1509, 1514 (N.D. Tex. 1995) (stating employer "was not required to deny other employees their vacation days so that they could work in place of [plaintiff]" and that cost of hiring an additional worker was more than *de minimis*).

[256] See, e.g., *Sutton v. Providence St. Joseph Med. Ctr.*, 192 F.3d 826, 830-31 (9th Cir. 1999) (holding that employer was not required to accommodate job applicant's religiously based refusal to provide his social security number where employer sought it to comply with Internal Revenue Service and Immigration and Naturalization Service requirements).

[257] See *infra* note 266.

[258] *Trans World Airlines, Inc. v. Hardison*, 432 U.S. 63, 83 (1977) (holding employer "was not required by Title VII to carve out a special exception to its seniority system in order to help [employee] to meet his religious obligations" of observing the Sabbath and not working on certain specified religious holidays); *Virts*, 285 F.3d at 517-18 (holding trucking firm had no obligation under Title VII to accommodate a driver's religious request for only male driving partners, where making assignments in this manner would have violated CBA); *Thomas v. Nat'l Ass'n of Letter Carriers*, 225 F.3d 1149, 1153, 1156 (10th Cir. 2000) (holding that because seniority system in the CBA gave more senior employees first choice for job assignments, it would be an undue hardship for employer to grant employee's accommodation request not to be

scheduled to work on Saturdays); *Mann v. Frank*, 7 F.3d 1365, 1369-70 (8th Cir. 1993) (finding no violation of the duty to accommodate where the union refused the employer's request to assign another worker to take plaintiff's Saturday shift, which would have violated CBA's provisions governing overtime).

[259] See *Balint v. Carson City*, 180 F.3d 1047, 1054 (9th Cir. 1999) (holding that "the existence of a neutral seniority system does not relieve the employer of its duty to reasonably accommodate the religious beliefs of its employees, so long as the accommodation can be accomplished without disruption of the seniority system and without more than a de minimis cost to the employer"); *EEOC v. Arlington Transit Mix, Inc.*, 957 F.2d 219, 222 (6th Cir. 1991) ("At a minimum, Arlington had an obligation to explore a voluntary waiver of seniority rights before terminating Taylor. After failing to pursue this or any other reasonable accommodation, the company is in no position to argue that it was unable to accommodate reasonably his religious needs without undue hardship on the conduct of its business.").

[260] See *Commission Guidelines*, 29 C.F.R. § 1605.2(e)(2); *Antoine v. First Student, Inc.*, 713 F.3d 824, 840 (5th Cir. 2013) (holding that allowing employee to voluntarily swap shifts was not an undue hardship where CBA authorized employer-facilitated voluntary route changes).

[261] *Lee v. ABF Freight Sys., Inc.*, 22 F.3d 1019, 1023-24 (10th Cir. 1994) (holding that the employer satisfied its Title VII obligation when it suggested method by which driver would usually be able to work the number of trips each week required under the union contract prior to the Sabbath, and could often use vacation time on other occasions; employer was not required to grant driver's request to skip assignments, which would then have to be worked by other drivers; his request to work less than other full-time drivers and reimburse employer for additional costs; or his request to transfer with no loss of seniority, which would violate its CBA, where the employer had sought but could not obtain a waiver from the union).

[262] See *Brown v. Polk Cnty.*, 61 F.3d 650, 655 (8th Cir. 1995) (en banc) (holding that allowing employee to assign secretary to type his Bible study notes posed more than *de minimis* cost because secretary would otherwise have been performing employer's work during that time); see also *Protos v. Volkswagen of Am., Inc.*, 797 F.2d 129, 134-35 (3d Cir. 1986) (no undue hardship where "efficiency, production, quality and morale . . . remained intact during [employee's] absence").

[263] See *Peterson v. Hewlett-Packard Co.*, 358 F.3d 599, 607-08 (9th Cir. 2004) (undue hardship for employer to accommodate employee's religiously motivated

posting of large signs in his cubicle which he “intended to be hurtful” and to demean and harass his coworkers); *Chalmers v. Tulon Co. of Richmond*, 101 F.3d 1012, 1021 (4th Cir. 1996) (undue hardship to accommodate “religious need” to send “personal, disturbing letters to [coworkers] accusing them of immorality”).

[264] See *Opuku-Boateng v. California*, 95 F.3d 1461, 1473 (9th Cir. 1996) (holding that mere complaints by other employees did not constitute undue hardship where employer failed to establish that accommodating employee’s religious holidays would have required more than *de minimis* cost or burden on coworkers).

[265] *Brown*, 61 F.3d at 655 (“Undue hardship requires more than proof of some fellow-worker’s grumbling. . . . An employer . . . would have to show . . . actual imposition on coworkers or disruption of the work routine.” (quoting *Burns v. S. Pac. Transp. Co.*, 589 F.2d 403, 407 (9th Cir. 1978) (alterations in original))).

[266] There may be different results depending on the specific setting and the religious garb at issue. See, e.g., *United States v. Essex Cnty.*, No. 09–2772 (KSH), 2010 WL 551393 (D.N.J. Feb. 16, 2010) (denying motion to dismiss, the court allowed the United States to proceed with denial-of-accommodation claim on behalf of Muslim employee of Essex County Department of Corrections who was denied accommodation of wearing her religious headscarf and terminated). But see *EEOC v. GEO Group, Inc.*, 616 F.3d 265, 273 (3d Cir. 2010) (rejecting EEOC’s claim that prison officials should have accommodated female Muslim employees by granting an exception to the dress code that would permit them to wear their khimars, but agreeing that there is no “per se rule of law about religious head coverings or safety,” even for police or paramilitary groups); *Webb v. City of Phila.*, 562 F.3d 256, 260–62 (3d Cir. 2009) (ruling that it would have posed an undue hardship to allow accommodation for a police officer who sought dress code exception to wear khimar); *Finnie v. Lee Cnty.*, 907 F. Supp. 2d 750, 780–81 (N.D. Miss. 2012) (ruling that evidence-supported safety concerns met burden of proving undue hardship would be posed by allowing religious exception to pants-only uniform policy for detention officers).

[267] The *Commission Guidelines*, 29 C.F.R. § 1605.2(d), set forth suggested methods of accommodating scheduling conflicts, but those methods are not intended to comprise an exhaustive list. Different factual circumstances will require different solutions. State wage and hour laws may provide certain limitations that affect an employer’s potential flexibility.

[268] See *supra* notes 227–229 and accompanying text.

[269] See *EEOC v. JBS USA, LLC*, 339 F. Supp. 3d 1135, 1182-83 (D. Colo. 2018) (not undue hardship to allow short unscheduled prayer breaks because “the preponderance of the evidence showed that allowing unscheduled prayer breaks would not have more than a de minimis effect on productivity or safety”); *Mohamed v. 1st Class Staffing, LLC*, 286 F. Supp. 3d 884, 910 (S.D. Ohio 2017) (suggesting that allowing employees to take break either 15 minutes early or 15 minutes late so that they could have the break room to themselves to pray would not be an undue hardship).

[270] *Cf. Protos v. Volkswagen of Am., Inc.*, 797 F.2d 129, 135 (3d Cir. 1986) (employer would not incur undue hardship from granting exception to mandatory Saturday overtime work for employee whose religious beliefs prevented her from working on her Sabbath, because employer did not have to pay higher wages to fill the vacancy).

[271] *Commission Guidelines*, 29 C.F.R. 1605.2(d)(i),

[272] See, e.g., *Beadle v. Hillsborough Cty. Sheriff’s Dep’t*, 29 F.3d 589, 593 (11th Cir. 1994) (finding that employer satisfied its accommodation obligation by providing employee a roster with his coworkers’ schedules and allowing employee to make announcement on bulletin board and at employee meeting to seek out coworkers willing to swap).

[273] See *Tabura v. Kellogg USA*, 880 F.3d 544, 555-57 (10th Cir. 2018) (remanding to determine whether employer satisfied its accommodation obligation by allowing employees to use paid leave and to seek volunteers to swap shifts to avoid working on their Sabbath, where employees had insufficient paid leave and plaintiffs had difficulty arranging voluntary swaps); *McGuire v. Gen. Motors Corp.*, 956 F.2d 607, 608-10 (6th Cir. 1992) (per curiam) (remanding to determine whether employer satisfied its accommodation obligation by allowing employee to swap shifts to avoid working on his Sabbath where employee found it “virtually impossible” to arrange voluntary swaps).

[274] See, e.g., *Smith v. Pyro Mining Co.*, 827 F.2d 1081, 1088-89 (6th Cir. 1987) (where plaintiff believed it was morally wrong to work on the Sabbath and that it was a sin to induce another employee to do so, it was not a reasonable accommodation for employer simply to be amenable to a shift swap; employer would not have incurred undue hardship by soliciting a replacement).

[275] *Commission Guidelines*, 29 C.F.R. § 1605.2(e)(1); see also *Redmond v. GAF Corp.*, 574 F.2d 897, 904 (7th Cir. 1978) (holding that employer could not demonstrate paying replacement worker premium wages would cause undue hardship because plaintiff would have been paid premium wages for the hours at issue); *EEOC v. Sw. Bell Tel. LP*, No. 3:06CV00176 JLH, 2007 WL 2891379, at *4 (E.D. Ark. Oct. 3, 2007) (finding that payment of premium wages for one day to allow two employees to attend yearly Jehovah's Witness convention as part of their religious practice, at alleged cost of \$220.72 per person in facility that routinely paid overtime, was not an undue hardship as a matter of law, where there was no evidence that customer service needs actually went unmet on the day at issue) (jury verdict for plaintiffs subsequently entered), *appeal dismissed*, 550 F.3d 704 (8th Cir. 2008).

[276] See *Noesen v. Med. Staffing Network, Inc.*, 232 F. App'x 581, 584-85 (7th Cir. 2007) (holding that employee's proposed accommodation of assigning responsibility for all initial customer contact to lower-paid technicians, even if it could be done, would impose an undue hardship because it would divert technicians from their assigned data input and insurance verification duties, resulting in uncompleted data work); see also *supra* note 238 (discussing potential application of federal conscience protection laws to health care employees).

[277] See *Noesen*, 232 F. App'x at 584.

[278] *Commission Guidelines*, 29 C.F.R. § 1605.2(d)(iii) ("When an employee cannot be accommodated either as to his or her entire job or an assignment within the job, employers and labor organizations should consider whether or not it is possible to change the job assignment or give the employee a lateral transfer."); see *Draper v. U.S. Pipe & Foundry Co.*, 527 F.2d 515, 519-20 (6th Cir. 1975) (holding that transfer involving substantial reduction in pay and that would have "wasted [plaintiff's] skills" would not be reasonable accommodation where plaintiff could have been accommodated in his original position without undue hardship). But see *Rodriguez v. City of Chi.*, 156 F.3d 771, 775 (7th Cir. 1998) (city's offer of lateral transfer was a reasonable accommodation, and therefore court need not consider whether it would have been an undue hardship for city to accommodate plaintiff in his original position).

[279] *Commission Guidelines*, 29 C.F.R. § 1605.2(d)(iii).

[280] See *Cook v. Lindsay Olive Growers*, 911 F.2d 233, 241 (9th Cir. 1990) (holding, under state law parallel to Title VII, that transfer of employee to a lower-level

position was reasonable where no equivalent position was available after employer attempted to find one and where employee would make more money overall because employee would work five shifts rather than four); *Draper*, 527 F.2d at 519-20 (holding that transfer involving substantial reduction in pay and that would have “wasted [plaintiff’s] skills” would not be reasonable accommodation where plaintiff could have been accommodated in his original position without undue hardship).

[281] See *Cassidy v. Detroit Edison Co.*, 138 F.3d 629, 634 (6th Cir. 1998) (“An employer may reassign an employee to a lower grade and paid position if the employee cannot be accommodated in the current position and a comparable position is not available.”) (ADA). At least one court has ruled that it is unreasonable for public protectors such as police officers or fire fighters to seek to be relieved from certain assignments as a religious accommodation. See *Endres v. Ind. State Police*, 349 F.3d 922, 927 (7th Cir. 2003) (holding that state police officer’s requested religious accommodation not to be assigned to full-time, permanent work at a casino was unreasonable, because police and fire departments “need the cooperation of all members” and need them to perform their duties “without favoritism”). However, Title VII does not distinguish between public protectors and other employees; it is not per se unreasonable for public protectors to obtain changes in job assignments, schedule changes, or transfers in situations where a conflict between their job duties and their religious beliefs could be eliminated or reduced. Title VII requires a fact-specific inquiry to determine whether granting a particular accommodation request would pose an undue hardship. See *Rodriguez*, 156 F.3d at 775 (city provided reasonable accommodation by giving police officer with religious objection to guarding abortion clinic opportunity to seek lateral transfer to district without abortion clinics); .

[282] See, e.g., *Anderson v. U.S.F. Logistics (IMC), Inc.*, 274 F.3d 470, 477 (7th Cir. 2001) (“In many cases, a company must modify its stated policies in practice to reasonably accommodate a religious practice.” (citing *Minkus v. Metro. Sanitary Dist.*, 600 F.2d 80 (7th Cir. 1979) (holding that municipal employer failed to accommodate a Jewish applicant when it followed its stated policy and scheduled civil service examinations only on Saturdays)).

[283] See, e.g., *EEOC v. United Parcel Serv.*, 94 F.3d 314, 320 (7th Cir. 1996) (reversing grant of summary judgment for employer because genuine issue of material fact existed regarding whether employer reasonably accommodated employee’s religious practice of wearing beard). See generally EEOC, Religious Garb and

Grooming in the Workplace: Rights and Responsibilities (2014), www.eeoc.gov/eeoc/publications/qa_religious_garb_grooming.cfm (https://www.eeoc.gov/eeoc/publications/qa_religious_garb_grooming.cfm).

[284] See *United Parcel Serv.*, 94 F.3d at 318-20; cf. *Daniels v. City of Arlington*, 246 F.3d 500, 505-06 (5th Cir. 2001) (finding no Title VII violations when it would be an unreasonable accommodation and undue hardship for the police to be forced to let individual officers add religious symbols to their uniforms, and the plaintiff failed to respond to reasonable offers of accommodation).

[285] See *Cloutier v. Costco Wholesale Corp.*, 390 F.3d 126, 136 (1st Cir. 2004) (holding that it would pose an undue hardship to require Costco to grant an exemption “because it would adversely affect the employer’s public image,” given Costco’s “determination that facial piercings . . . detract from the ‘neat, clean and professional image’ that it aims to cultivate”); cf. *Brown v. F.L. Roberts & Co.*, 419 F. Supp. 2d 7, 17 (D. Mass. 2006) (stating it was bound to follow *Cloutier* as the law of the circuit and holding that no Title VII violation occurred when employer transferred lube technician whose Rastafarian religious beliefs prohibited him from shaving or cutting his hair to a location with limited customer contact because he could not comply with a new grooming policy, but observing in dicta: “If *Cloutier*’s language approving employer prerogatives regarding ‘public image’ is read broadly, the implications for persons asserting claims for religious discrimination in the workplace may be grave. One has to wonder how often an employer will be inclined to cite this expansive language to terminate or restrict from customer contact, on image grounds, an employee wearing a yarmulke, a veil, or the mark on the forehead that denotes Ash Wednesday for many Catholics. More likely, and more ominously, considerations of ‘public image’ might persuade an employer to tolerate the religious practices of predominant groups, while arguing ‘undue hardship’ and ‘image’ in forbidding practices that are less widespread or well known.”).

[286] See *EEOC v. Abercrombie & Fitch Stores, Inc.*, 135 S. Ct. 2028, 2031, 2034 (2015) (recognizing, in case where the employer’s grooming policy prohibited “caps” as “too informal for [its] desired image,” that “Title VII requires otherwise-neutral policies,” such as a no-headwear dress code, “to give way to the need for an accommodation”). Denying the employer’s motion for summary judgment in *EEOC v. Red Robin Gourmet Burgers, Inc.*, No. C04–1291JLR, 2005 WL 2090677, at *5 (W.D. Wash. Aug. 29, 2005), the court ruled that notwithstanding the employer’s purported reliance on a company profile and customer study suggesting that it seeks to present a family-oriented and kid-friendly image, the company failed to

demonstrate that allowing an employee to have visible religious tattoos was inconsistent with these goals. “Hypothetical hardships based on unproven assumptions typically fail to constitute undue hardship. . . . [The employer] must provide evidence of ‘actual imposition on coworkers or disruption of the work routine’ to demonstrate undue hardship.” *Id.*

[287] See *United States v. N.Y. City Trans. Auth.*, No. 04–CV–4237, 2010 WL 3855191, at *22 (E.D.N.Y. Sept. 28, 2010) (holding that pattern-or-practice claim could proceed on behalf of Muslim and Sikh bus drivers, train operators, and subway station agents alleging selective enforcement of city’s headwear policies and failure to accommodate Muslim and Sikh employees who could not comply for religious reasons); see also *EEOC v. Am. Airlines*, Civil Action No. 02-C-6172 (N.D. Ill.) (Order of Resolution filed September 3, 2002) (resolving claim on behalf of employee who was not hired as passenger service agent because she wore a hijab for religious reasons in violation of the airline’s since-changed uniform policy; the airline’s current uniform policy specifically contemplates exceptions for religious accommodation of employees); see also *EEOC v. Alamo Rent-A-Car, LLC*, 432 F. Supp. 2d 1006, 1015-17 (D. Ariz. 2006) (holding employer violated Title VII by instructing employee she would have to remove her religious garb whenever interacting with customers, and work in the back office when she wore it).

[288] See *Webb v. City of Phila.*, 562 F.3d 256, 260-62 (3d Cir. 2009) (holding that municipal employer established as a matter of law that it would pose an undue hardship to accommodate wearing of traditional religious headpiece called a khimar by Muslim police officer while in uniform, in contravention of the department’s dress code directive). *But cf. Fraternal Order of Police v. City of Newark*, 170 F.3d 359, 366 (3d Cir. 1999) (explaining that police department’s interests in “fostering a uniform appearance through its ‘no-beard’ policy” and in security were undermined when it allowed officers to wear beards for medical reasons and holding that department’s refusal to allow officers also to wear beards for religious reasons violated the Free Exercise Clause).

[289] *Cf. Federal Workplace Guidelines*, *supra* note 119 § 1.C (“Accommodation of Religious Exercise”), example (d) (government workplaces that allow employees to use facilities for non-work-related secular activities generally are required to allow the privilege on equal terms for employee religious activities).

[290] See, e.g., *Minkus v. Metro. Sanitary Dist.*, 600 F.2d 80, 81-82 (7th Cir. 1979); *Cary v. Carmichael*, 908 F. Supp. 1334, 1343-46 (E.D. Va. 1995) (holding that employee

failed to give employer proper notice so that it could attempt an accommodation of his religious objection to signing consent form for a drug test), *aff'd sub nom*, 116 F.3d 472 (4th Cir. 1997).

[291] See, e.g., *Minkus*, 600 F.2d at 82-84 (holding that employer must demonstrate it would pose undue hardship to allow applicant to take exam at different time than others as a religious accommodation).

[292] See, e.g., *Yeager v. FirstEnergy Generation Corp.*, 777 F.3d 362, 363-64 (6th Cir. 2015) (per curiam) (holding that excusing employee from providing social security number was not required under Title VII because it would require employer to violate another federal law, without reaching issue of whether it constituted an undue hardship); *Sutton v. Providence St. Joseph Med. Ctr.*, 192 F.3d 826, 830-31 (9th Cir. 1999) (holding that excusing employee from providing social security number would cause undue hardship because it would require violation of another federal law); *Cherry v. Sunoco, Inc.*, No. 07-cv-2235, 2009 WL 2518221, at *7 (E.D. Pa. Aug. 17, 2009) (holding that it would have posed undue hardship on refinery operator to excuse photo identification requirement imposed on employer by U.S. Coast Guard regulations after exemption was denied); cf. *Lizalek v. Invivo Corp.*, 314 F. App'x 881, 882 (7th Cir. 2009) (holding that it would pose an undue hardship to accommodate employee's religious belief that he was exempt from any tax liability and could use multiple names on forms, in part because it would expose employer to potential IRS issues).

[293] See, e.g., *EEOC v. Consol Energy, Inc.*, 860 F.3d 131, 143 (4th Cir. 2017) (affirming judgment against employer that denied coal mine employee's requested religious accommodation of alternative means to clock in and out when the company adopted a "biometric hand scanner" system that conflicted with his Christian faith, where the evidence showed employer had available an alternative clock-in system for miners who were physically incapable of scanning their hands, but failed to provide it as a religious accommodation), *cert. denied*, 138 S. Ct. 976 (2018).

[294] See *Commission Guidelines*, 29 C.F.R. § 1605.2(d)(2); *Tooley v. Martin Marietta Corp.*, 648 F.2d 1239, 1242-44 (9th Cir. 1981) (holding that a union could not force an employer, under a contractual union security clause, to terminate three Seventh-day Adventists who offered to pay an amount equivalent to dues to a nonreligious charity because union failed to show that such an accommodation would deprive it of funds needed for its maintenance and operation); *EEOC v. Univ. of Detroit*, 904

F.2d 331 (6th Cir. 1990) (remanding for determination whether employer could reasonably accommodate without undue hardship employee's religious objection to associating with certain organizations); *Burns v. S. Pac. Transp. Co.*, 589 F.2d 403, 406-07 (9th Cir. 1978) (holding that allowing an equivalent charitable contribution in lieu of dues did not constitute undue hardship notwithstanding administrative cost to union and "grumbings" by other employees); *Cooper v. Gen. Dynamics*, 533 F.2d 163 (5th Cir. 1976) (holding that religious belief that supporting labor union violated the precept "to love" one's neighbor, i.e., employers, was subject to reasonable accommodation absent undue hardship).

[295] See *McDaniel v. Essex Int'l, Inc.*, 696 F.2d 34, 37-38 (6th Cir. 1982) (finding that employee's proposal to donate amount equivalent to dues to a "mutually agreeable" charity was reasonable accommodation that would not have posed undue hardship); *EEOC v. Am. Fed'n of State, Cty. & Mun. E'ees*, 937 F. Supp. 166, 168 (N.D.N.Y. 1996) (holding that donation of shop fee to agreed-upon charity was reasonable accommodation for employee's religious belief). Some collective bargaining agreements have charities listed in them, pursuant to the requirements of section 19 of the National Labor Relations Act. See 29 U.S.C. § 169. At least one court has held that it may be inappropriate to require the religious objector to pay the full amount of the union dues to a charitable organization, however, if non-religious objectors are permitted to pay a reduced amount. See *O'Brien v. City of Springfield*, 319 F. Supp. 2d 90 (D. Mass. 2003) (holding, in part, it was not a reasonable accommodation to require religious objector to pay full union dues where state statute permitted non-union members to pay a lower amount in form of agency fee). But see *Madsen v. Associated Chino Teachers*, 317 F. Supp. 2d 1175, 1179 (C.D. Cal. 2004) (holding it was not disparate treatment under Title VII to require religious objectors to pay full amount of dues to charity where non-religious objectors were only paying agency fee to union).

[296] See *Commission Guidelines*, 29 C.F.R. § 1605.2(e); *Nottelson v. Smith Steel Workers D.A.L.U.* 19806, 643 F.2d 445, 450-51 (7th Cir. 1981) (holding that charity-substitute religious accommodation for union dues did not pose undue hardship to union where loss of plaintiff's dues represented only .02% of union's annual budget, and union presented no evidence that the loss of receipts from plaintiff would necessitate an increase in dues of his coworkers, that other workers would seem similar accommodations, or that the accommodation would lead to labor strife); see also *Burns*, 589 F.2d at 407 (holding that excusing employee from paying his monthly \$19 union dues did not pose undue hardship, where one union officer testified that the loss "wouldn't affect us at all" and union's asserted fear of many

religious objectors was based on mere speculation, but noting that if “in the future, the expressed fear of widespread refusal to pay union dues on religious grounds should become a reality, undue hardship could be proved”).

[297] See *Univ. of Detroit*, 904 F.2d at 335.

[298] See *Wilson v. U.S. W. Commc’ns*, 58 F.3d 1337, 1341-42 (8th Cir. 1995) (given disruption actually caused among coworkers in workplace, employer reasonably accommodated employee’s request to wear at all times a button containing a graphic photograph of a fetus with anti-abortion message by requiring her to cover up the photograph portion when she was at work); cf. *EEOC v. Red Robin Gourmet Burgers, Inc.*, No. C04-1291JLR, 2005 WL 2090677, at *4-5 (W.D. Wash. Aug. 29, 2005) (denying employer’s motion for summary judgment because issue of whether employee’s Kemetite religious wrist tattoos would disrupt work or otherwise pose an undue hardship raised a disputed factual question to be decided by jury).

[299] *Faragher v. Boca Raton*, 524 U.S. 775, 802-03 (1998); *Burlington Indus., Inc. v. Ellerth*, 524 U.S. 742, 759-60 (1998); see *Peterson v. Hewlett-Packard Co.*, 358 F.3d 599, 607 (9th Cir. 2004) (“[A]n employer need not accommodate an employee’s religious beliefs if doing so would result in discrimination against his coworkers or deprive them of contractual or other statutory rights.”).

[300] See *Ervington v. LTD Commodities, LLC*, 555 F. App’x 615, 616-18 (7th Cir. 2014) (in suit challenging discharge where plaintiff’s proselytizing violated the company’s anti-harassment policy because the religious pamphlets she distributed were offensive to her coworkers, ruling that the employer was not required to accommodate distribution of pamphlets that were offensive to other employees, and rejecting plaintiff’s argument that the harassment was not “unlawful” by noting that the statute “does not prohibit employers from enforcing an antiharassment policy that defines harassment more broadly than does Title VII”); *Wilson*, 58 F.3d at 1341-42 (holding that employer did not violate Title VII when it fired employee who refused to cover up a “graphic anti-abortion button” while at work; the court reasoned that plaintiff’s requested accommodation that the employer “simply instruct [her] coworkers that they must accept [the plaintiff]’s insistence on wearing a particular depiction of a fetus as part of her religious beliefs is antithetical to the concept of reasonable accommodation” denied certain accommodation options because of demonstrated disruption to coworkers because it had provided a reasonable option that would not be disruptive); *Brown v. Polk Cnty.*, 61 F.3d 650, 656-57 (8th Cir. 1995) (en banc) (ruling employer did not establish that supervisor’s

“occasional spontaneous prayers and isolated references to Christian beliefs” posed an undue hardship because, although the employer asserted that the supervisor’s conduct had polarized employees along religious lines, it provided no evidence of “actual imposition on coworkers or disruption of the work routine”); *Rightnour v. Tiffany & Co.*, 354 F. Supp. 3d 511, 525 (S.D.N.Y. 2019) (in suit challenging the plaintiff’s termination for poor performance and offensive religion-related comments she had made, explaining that “it does not constitute discrimination to discipline employees for making offensive comments in the workplace, even when those comments are tied to religion”); *Averett v. Honda of Am. Mfg., Inc.*, No. 2:07-cv-1167, 2010 WL 522826, at *8-10 (S.D. Ohio Feb. 9, 2010) (in suit challenging discipline and eventual termination of plaintiff for repeatedly making written and oral statements that her coworkers were sinful and evil people whom God would punish, explaining “Title VII does not require employer to allow an employee to impose her religious views on others” (internal quotation marks and citation omitted)).

[301] See *Ellerth*, 524 U.S. at 765; *Faragher*, 524 U.S. at 807.

[302] See *Anderson v. U.S.F. Logistics (IMC), Inc.*, 274 F.3d 470, 476 (7th Cir. 2001) (holding that employer reasonably accommodated plaintiff’s religious practice of sporadically using the phrase “Have a Blessed Day” when it permitted her to use the phrase with coworkers and supervisors who did not object, but prohibited her from using the phrase with customers where at least one regular client objected; allowing her to use the phrase with customers who objected would have posed an undue hardship); see also *Banks v. Serv. Am. Corp.*, 952 F. Supp. 703, 710-11 (D. Kan. 1996) (holding that plaintiff food service employees at company cafeteria, who were terminated when they refused to stop greeting customers with phrases such as “God Bless You” and “Praise the Lord,” presented a triable issue of fact regarding whether they could have been accommodated without undue hardship, because in the absence of employer proof that permitting the statements was disruptive or that it had any legitimate reason to fear losing business, a reasonable jury could conclude that no undue hardship was posed).

[303] See, e.g., *Lizalek v. Invivo Corp.*, 314 F. App’x 881, at *2 (7th Cir. 2009) (holding that it would have posed undue hardship to accommodate employee’s need to alternate among different identities pursuant to his religious belief that he was three separate beings, where evidence showed employee’s practice of alternating between identities in e-mail correspondence endangered the company’s customer relationships and made it difficult for him to communicate with coworkers, and required management to devote “an inordinate amount of time to [the plaintiff’s]

various requests”); *Johnson v. Halls Merch., Inc.*, No. 87–1042–CV–W–9, 1989 WL 23201 (W.D. Mo. Jan. 17, 1989) (holding that it would have posed undue hardship on employer to permit retail employee’s regular statement to customers “in the name of Jesus Christ of Nazareth,” because it offended the beliefs of some customers and therefore cost the company business); see also *infra* notes 304-07.

[304] See *Mial v. Foxhoven*, 305 F. Supp. 3d 984 (N.D. Iowa 2018) (holding that employer had not presented sufficient evidence to show as a matter of law that it would suffer undue hardship if required to accommodate employee who began signing internal business emails to coworkers “In Christ,” because fact issues existed regarding whether the communications would cause anyone to perceive that the employer government agency was endorsing Christianity, or that the communications caused disruption in the workplace or violated any neutral, generally applicable rules or procedures).

[305] See *Knight v. Conn. Dep’t of Pub. Health*, 275 F.3d 156, 164-65 (2d Cir. 2001) (holding that allowing an employee to evangelize clients would not be reasonable because it would jeopardize the state employer’s ability to provide services in a religion-neutral manner); *Rivera v. Choice Courier Sys., Inc.*, No. 01 Civ.2096 (CBM), 2004 WL 1444852, at *10 (S.D.N.Y. June 25, 2004) (holding that genuine issue of material fact existed as to whether courier was denied reasonable accommodation where courier alleged that employer could have accommodated courier’s need to evangelize by transferring him to a position with a less stringent dress code that would have allowed employee to continue wearing a patch stating “Jesus is Lord”).

[306] Cf. *Dixon v. Hallmark Cos.*, 627 F.3d 849, 855-56 (11th Cir. 2010) (ruling that apartment complex property manager could proceed to trial on claim challenging termination for violating the employer’s religious displays policy by refusing to remove a poster of flowers with the words “Remember the Lilies . . . Matthew 6:28” she had hung in the on-site management office, where the employer also terminated the plaintiff’s husband, telling him, “You’re fired too. You’re too religious.”); *Johnson*, 1989 WL 23201 (holding that it would have posed undue hardship on employer to permit retail employee’s regular statement to customers “in the name of Jesus Christ of Nazareth,” because it offended the beliefs of some customers). Moreover, a private employer’s own rights under the First Amendment Free Speech Clause may provide a defense to a Title VII accommodation claim, if the proposed accommodation would require the private employer involuntarily to display a religious message that could be construed as its own. See also *infra* § 12-IV-C-7.

[307] See *Knight*, 275 F.3d at 168; *Grant v. Fairview Hosp. & Healthcare Servs.*, 02–4232JNEJGL, 2004 WL 326694, at *5 (D. Minn. Feb. 18, 2004) (finding that an ultrasound technician whose religious beliefs required him to dissuade women from having abortions was offered a reasonable accommodation when hospital restricted him from doing so but gave permission for him to be excused from performing ultrasounds on women it knew were contemplating abortions); see also *Grossman v. S. Shore Pub. Sch. Dist.*, 507 F.3d 1097, 1100 (7th Cir. 2007) (affirming summary judgment for school district on terminated guidance counselor’s First Amendment free exercise and Title VII claims, the court ruled that the school district was permitted to terminate counselor for conduct, even if her actions of praying with students who approached her for guidance and throwing away school contraceptive education materials were motivated by her religious beliefs; there was insufficient evidence that her termination was based on her religious views alone as opposed to these actions, which the school district was entitled to prohibit).

[308] See *Townley*, 859 F.2d at 619–21 (noting private employer has First Amendment free exercise right to express its religion in the workplace). *Cf.*, e.g., *Burwell v. Hobby Lobby Stores, Inc.*, 573 U.S. 682, 703 (2014) (describing how family-owned company has statement of purpose to “[h]onor[] the Lord in all [they] do by operating the company in a manner consistent with Biblical principles”; “[e]ach family member has signed a pledge to run the businesses in accordance with the family’s religious beliefs and to use the family assets to support Christian ministries”; their stores are closed on Sundays, despite the loss of millions in sales annually; “[t]he businesses refuse to engage in profitable transactions that facilitate or promote alcohol use; they contribute profits to Christian missionaries and ministries; and they buy hundreds of full-page newspaper ads inviting people to ‘know Jesus as Lord and Savior’” (first and third alteration in original)).

[309] See *Young v. Sw. Sav. & Loan Ass’n*, 509 F.2d 140, 144–45 (5th Cir. 1975); see, e.g., *EEOC v. United Health Programs of Am., Inc.*, 350 F. Supp. 3d 199, 240–41 (E.D.N.Y. 2018) (awarding attorney’s fees, injunctive relief, and costs in addition to the jury’s award of compensatory and punitive damages to plaintiff where the employer coerced employees to engage in religious practices at work, creating a hostile work environment based on religion, and terminated an employee who opposed those practices). Alternatively, an employee may argue simply that mandating attendance in a religious service, without exception, adversely affects the terms and conditions of employment based on religion.

[310] See *Mathis v. Christian Heating & Air Conditioning, Inc.*, 158 F. Supp. 3d 317, 333 (E.D. Pa. 2016) (denying summary judgment for the employer where plaintiff, an atheist, sought to refrain from wearing an employee ID badge with the employer's Christian message, because although the employer's message was intended to communicate "what we believe and how we want to be perceived by the public," a reasonable jury could find no harm to the company if its message was not displayed on plaintiff's badge); *EEOC v. Townley Eng'g & Mfg. Co.*, 859 F.2d 610, 614-21 (9th Cir. 1988) (employer must accommodate an employee's atheism; no undue hardship because excusing employee from services would not have cost anything nor caused a disruption).

[311] See *Young*, 509 F.2d at 144-45 (ruling that employee was constructively discharged based on her religion in violation of Title VII where her superior advised her that she had obligation to attend monthly staff meetings in their entirety and advised her that she could simply "close her ears" during religious exercises with which meetings began).

[312] See *Garry H. v. Dep't of Transp.*, EEOC Appeal No. 0120181570, 2019 WL 4945081, at *2 (Sept. 24, 2019) (recognizing that holiday decorations such as a sign stating "Santa Claus[] is coming in [x number] of days" and Christmas lights are "secular symbols rather than an expression of a religion," and concluding that "displaying them in the federal workplace does not violate the establishment clause of the First Amendment," and does not constitute disparate treatment or hostile work environment harassment based on religion; noting the employer is not required by Title VII either to take them down or to add decorations representing other religions); see also *Federal Workplace Guidelines*, *supra* note 119 at Section D, example (b) (a government workplace does not violate the Establishment Clause by hanging a wreath or other secular Christmas decorations).

[313] Although it is beyond the scope of Title VII enforcement, we note for the sake of completeness that the U.S. Supreme Court has held that wreaths and Christmas trees are "secular" symbols, akin to items such as lights, Santa Claus, and reindeer, and thus that government display of these items does not violate the Establishment Clause of the First Amendment. See *Cnty. of Allegheny v. ACLU*, 492 U.S. 573, 616-17 (1989) (holding that stand-alone crèche on county courthouse steps violated Establishment Clause, but display elsewhere of Christmas tree next to a menorah and a sign proclaiming "liberty" did not), *abrogated on other grounds Town of Greece v. Galloway*, 572 U.S. 565 (2014); cf. *Lynch v. Donnelly*, 465 U.S. 668, 670, 683-87 (1984) (holding that government-sponsored display of crèche did not violate

Establishment Clause because it was surrounded by various secular symbols as part of holiday display) ; *Federal Workplace Guidelines*, *supra* note 119 at Section D (example (b)). For a discussion of both Title VII and Establishment Clause claims arising from holiday decorations in federal government employment context, see, e.g., *Spohn v. West*, No. 00 CIV. 0735 AJP, 2000 WL 1459981, at *4-5 (S.D.N.Y. Oct. 2, 2000). In the private sector, Establishment Clause constraints would not apply.

[314] An employer may accommodate the employee's religious belief by substituting an alternative technique or method that does not conflict with the employee's religious belief or by excusing the employee from that part of the training program that poses a conflict, if doing so would not pose an undue hardship.

[315] Many employers have policies that require employees to treat each other with "courtesy, dignity and respect." This terminology fits within the ambit of treating others "professionally" as used in the example. See *Peterson v. Hewlett-Packard Co.*, 358 F.3d 599, 606-08 (9th Cir. 2004) (holding that it would have constituted undue hardship for employer to accommodate employee by eliminating portions of its diversity program to which employee raised religious objections; to do so would have "infringed upon the company's right to promote diversity and encourage tolerance and good will among its workforce"). If training conflicts with an employee's religious beliefs, the content of the training materials may be determinative in deciding whether it would pose an undue hardship to accommodate an employee by excusing him or her from the training or a portion thereof. If the training required or encouraged employees to affirmatively support or agree with conduct that conflicts with the employee's religious beliefs, or signal their support of certain values that conflict with the employee's religious beliefs, it would be more difficult for an employer to establish that it would pose an undue hardship to accommodate an employee who objects to participating on religious grounds. See *Buonanno v. AT&T Broadband, LLC*, 313 F. Supp. 2d 1069, 1081-83 (D. Colo. 2004) (holding that a company could require and instruct employees to treat coworkers with respect in accordance with corporate diversity policy, but that a violation of Title VII occurred where the company did not accommodate employee's refusal on religious grounds to sign diversity policy asking him to "value the differences among all of us," which he believed required him to ascribe worth to a certain behaviors or beliefs he believed were repudiated by Scripture rather than simply agree to treat his coworkers appropriately).

[316] See *Commission Guidelines*, 29 C.F.R. § 1605.2(c).

[317] See *EEOC v. WC&M Enters., Inc.*, 496 F.3d 393, 401-02 (5th Cir. 2007) (holding that evidence was sufficient for employee to proceed to trial on claim that he was subjected to hostile work environment harassment based on both religion and national origin where harassment was motivated both by his being a practicing Muslim and by his having been born in India); *Vitug v. Multistate Tax Comm’n*, 88 F.3d 506, 515 (7th Cir. 1996) (holding that Catholic Filipino employee made out a prima facie case of national origin and religious discrimination).

[318] See *Raad v. Fairbanks N. Star Borough Sch. Dist.*, 323 F.3d 1185, 1196 (9th Cir. 2003) (denying employer’s summary judgment motion on Lebanese Muslim substitute school teacher’s discrimination claim because a reasonable jury could conclude that preconceptions about her religion and national origin caused school officials to misinterpret her comment that she was angry but did not want to “blow up”); *Tolani v. Upper Southampton Twp.*, 158 F. Supp. 2d 593, 596-97 (E.D. Pa. 2001) (ruling that employee from India who was Asian stated a claim of discriminatory discharge based on race, religion, and national origin sufficient to survive summary judgment because employer mocked the way Indian people worship).

[319] 42 U.S.C. § 2000e-3(a); see also *Burlington N. v. Santa Fe Ry. Co. v. White*, 548 U.S. 53 (2006).

[320] 42 U.S.C. § 2000e-3(a); see, e.g., *Magden v. Easterday Farms*, No. 2:16-CV-00068-JLQ, 2017 WL 1731705, at *8 (E.D. Wash. May 3, 2017) (holding plaintiff could proceed with retaliatory termination claim when he was fired for alleged poor performance two days after he complained to management about supervisor’s proselytizing, management took no steps to investigate, and supervisor confronted him about complaint).

[321] See EEOC, Enforcement Guidance on Retaliation & Related Issues II.A.2(e) (Aug. 25, 2016), <https://www.eeoc.gov/laws/guidance/enforcement-guidance-retaliation-and-related-issues> (<https://www.eeoc.gov/laws/guidance/enforcement-guidance-retaliation-and-related-issues>). In a related context, most courts have assumed or held that requests for disability accommodation are protected activity. See *Solomon v. Vilsack*, 763 F.3d 1, 15 n.6 (D.C. Cir. 2014) (collecting cases); see also 9 Lex K. Larson, Employment Discrimination § 154.10, at 154-105 & n.25 (2d ed. 2014) (“In addition to the activities specifically protected by the statute, courts have found that requesting reasonable accommodation is a protected activity.”). One circuit has held that requesting a religious accommodation, in contrast to opposing the denial of such a request, is not a

protected activity under 42 U.S.C. § 2000e-3(a), and thus that a claim that a prospective employer had wrongfully denied a Seventh-day Adventist's request not to work during her Sabbath (Friday sundown to Saturday sundown) should have been brought as a disparate treatment claim under 42 U.S.C. § 2000e-2(a) instead. See *EEOC v. N. Mem'l Health Care*, 908 F.3d 1098, 1102–04 (8th Cir. 2019). The Commission disagrees with that decision and believes the better interpretation of Title VII's antiretaliation provision is that requests for religious accommodations are protected activity under that provision as well.

[322] *Burlington N.*, 548 U.S. at 68 (quotations omitted).

[323] Executive Order 13609 is inapplicable because the interpretive guidelines are nonbinding and have no impact on international regulatory cooperation or on interactions with other countries.

[324] Although www.regulations.gov (<http://www.regulations.gov>) numbers comments received as 74, the numbering excludes one and ten, and document number 54 is a duplicate. Therefore, there were 71 unique comments.



COVID-19

Selected Adverse Events Reported after COVID-19 Vaccination

Updated Oct. 13, 2021

[Print](#)

Safety of COVID-19 Vaccines

Some people have no side effects. Many people have reported side effects that may affect their ability to do daily activities, but they should go away within a few days.

What You Need to Know


- COVID-19 vaccines are **safe and effective**.
- Millions of people in the United States have received COVID-19 vaccines under the most intense safety monitoring in U.S. history.
- CDC recommends everyone 12 years and older get vaccinated as soon as possible to help protect against COVID-19 and the related, potentially severe complications that can occur.
- CDC, the U.S. Food and Drug Administration (FDA), and other federal agencies are monitoring the safety of COVID-19 vaccines.
- Adverse events described on this page have been reported to the [Vaccine Adverse Event Reporting System \(VAERS\)](#) [↗](#).
- VAERS accepts reports of any adverse event following any vaccination.
- Reports of adverse events to VAERS following vaccination, including deaths, do not necessarily mean that a vaccine caused a health problem.

Serious adverse events after COVID-19 vaccination are rare but may occur.

For public awareness and in the interest of transparency, CDC is providing timely updates on the following serious adverse events of interest:

- **Anaphylaxis after COVID-19 vaccination is rare** and has occurred in approximately 2 to 5 people per million vaccinated in the United States. Severe allergic reactions, including anaphylaxis, can occur after any vaccination. If this occurs, vaccination providers can effectively and immediately treat the reaction. Learn more about COVID-19 vaccines and allergic reactions, including [anaphylaxis](#).
- **Thrombosis with thrombocytopenia syndrome (TTS) after Johnson & Johnson's Janssen (J&J/Janssen) COVID-19 vaccination is rare.** As of October 6, 2021, more than 15 million doses of the J&J/Janssen COVID-19 Vaccine have been given in the United States. CDC and FDA identified 47 confirmed reports of people who got the J&J/Janssen COVID-19 Vaccine and later developed TTS. Women younger than 50 years old especially should be aware of the rare but increased risk of this adverse event. There are other COVID-19 vaccine options available for which this risk has not been seen. [Learn more about J&J/Janssen COVID-19 Vaccine and TTS.](#)
 - To date, two confirmed cases of TTS following mRNA COVID-19 vaccination (Moderna) have been reported to VAERS after more than 382 million doses of [mRNA COVID-19 vaccines](#) administered in the United States. Based on available data, there is not an increased risk for TTS after mRNA COVID-19 vaccination.

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- CDC and FDA are monitoring reports of [Guillain-Barré Syndrome](#) (GBS) in people who have received the J&J/Janssen COVID-19 Vaccine. GBS is a rare disorder where the body's immune system damages nerve cells, causing muscle weakness and sometimes paralysis. Most people fully recover from GBS, but some have permanent nerve damage. After more than 15 million J&J/Janssen COVID-19 Vaccine doses administered, there have been around 228 preliminary reports of GBS identified in VAERS as of October 6, 2021. These cases have largely been reported about 2 weeks after vaccination and mostly in men, many 50 years and older. CDC will continue to monitor for and evaluate reports of GBS occurring after COVID-19 vaccination and will share more information as it becomes available.
- **Myocarditis and pericarditis after COVID-19 vaccination are rare.** As of October 6, 2021, VAERS has received 1,640 reports of myocarditis or pericarditis among people ages 30 and younger who received COVID-19 vaccine. Most cases have been reported after mRNA COVID-19 vaccination (Pfizer-BioNTech or Moderna), particularly in male adolescents and young adults. Through follow-up, including medical record reviews, CDC and FDA have confirmed 926 reports of myocarditis or pericarditis. CDC and its partners are investigating these reports to assess whether there is a relationship to COVID-19 vaccination. [Learn more about COVID-19 vaccines and myocarditis.](#)
- **Reports of death after COVID-19 vaccination are rare.** More than 403 million doses of COVID-19 vaccines were administered in the United States from December 14, 2020, through October 6, 2021. During this time, VAERS received 8,638 reports of death (0.0021%) among people who received a COVID-19 vaccine. FDA requires healthcare providers to report any death after COVID-19 vaccination to VAERS, even if it's unclear whether the vaccine was the cause. **Reports of adverse events to VAERS following vaccination, including deaths, do not necessarily mean that a vaccine caused a health problem.** A review of available clinical information, including death certificates, autopsy, and medical records, has not established a causal link to COVID-19 vaccines. However, recent reports indicate a plausible causal relationship between the [J&J/Janssen COVID-19 Vaccine and TTS](#), a rare and serious adverse event—blood clots with low platelets—which has caused deaths  [1.4 MB, 40 pages].

Related Pages

- › [Safety of COVID-19 Vaccines](#)
- › [Vaccine Adverse Event Reporting System \(VAERS\): What Reports Mean and How VAERS Works](#)

Last Updated Oct. 13, 2021



Original Investigation | Infectious Diseases

Serologic Surveillance and Phylogenetic Analysis of SARS-CoV-2 Infection Among Hospital Health Care Workers

Jonne J. Sikkens, MD, PhD; David T. P. Buis, MD; Edgar J. G. Peters, MD, PhD; Mireille Dekker, MSc; Michiel Schinkel, MD; Tom D. Y. Reijnders, MD; Alex. R. Schuurman, MD; Justin de Brabander, MD; A. H. Ayesha Lavell, MD; Jaap J. Maas, MD, PhD; Jelle Koopsen, MSc; Alvin X. Han, PhD; Colin A. Russell, PhD; Janke Schinkel, MD, PhD; Marcel Jonges, PhD; Sébastien Matamoros, PhD; Suzanne Jurriaans, PhD; Rosa van Mansfeld, MD, PhD; W. Joost Wiersinga, MD, PhD; Yvo M. Smulders, MD, PhD; Menno D. de Jong, MD, PhD; Marije K. Bomers, MD, PhD

Abstract

IMPORTANCE It is unclear when, where, and by whom health care workers (HCWs) working in hospitals are infected with SARS-CoV-2.

OBJECTIVE To determine how often and in what manner nosocomial SARS-CoV-2 infection occurs in HCW groups with varying exposure to patients with COVID-19.

DESIGN, SETTING, AND PARTICIPANTS This cohort study comprised 4 weekly measurements of SARS-CoV-2-specific antibodies and collection of questionnaires from March 23 to June 25, 2020, combined with phylogenetic and epidemiologic transmission analyses at 2 university hospitals in the Netherlands. Included individuals were HCWs working in patient care for those with COVID-19, HCWs working in patient care for those without COVID-19, and HCWs not working in patient care. Data were analyzed from August through December 2020.

EXPOSURES Varying work-related exposure to patients infected with SARS-CoV-2.

MAIN OUTCOMES AND MEASURES The cumulative incidence of and time to SARS-CoV-2 infection, defined as the presence of SARS-CoV-2-specific antibodies in blood samples, were measured.

RESULTS Among 801 HCWs, there were 439 HCWs working in patient care for those with COVID-19, 164 HCWs working in patient care for those without COVID-19, and 198 HCWs not working in patient care. There were 580 (72.4%) women, and the median (interquartile range) age was 36 (29-50) years. The incidence of SARS-CoV-2 was increased among HCWs working in patient care for those with COVID-19 (54 HCWs [13.2%; 95% CI, 9.9%-16.4%]) compared with HCWs working in patient care for those without COVID-19 (11 HCWs [6.7%; 95% CI, 2.8%-10.5%]; hazard ratio [HR], 2.25; 95% CI, 1.17-4.30) and HCWs not working in patient care (7 HCWs [3.6%; 95% CI, 0.9%-6.1%]; HR, 3.92; 95% CI, 1.79-8.62). Among HCWs caring for patients with COVID-19, SARS-CoV-2 cumulative incidence was increased among HCWs working on COVID-19 wards (32 of 134 HCWs [25.7%; 95% CI, 17.6%-33.1%]) compared with HCWs working on intensive care units (13 of 186 HCWs [7.1%; 95% CI, 3.3%-10.7%]; HR, 3.64; 95% CI, 1.91-6.94), and HCWs working in emergency departments (7 of 102 HCWs [8.0%; 95% CI, 2.5%-13.1%]; HR, 3.29; 95% CI, 1.52-7.14). Epidemiologic data combined with phylogenetic analyses on COVID-19 wards identified 3 potential HCW-to-HCW transmission clusters. No patient-to-HCW transmission clusters could be identified in transmission analyses.

CONCLUSIONS AND RELEVANCE This study found that HCWs working on COVID-19 wards were at increased risk for nosocomial SARS-CoV-2 infection with an important role for HCW-to-HCW

(continued)

Key Points

Question Which hospital health care workers are at increased risk for SARS-CoV-2 infection, and by whom are they infected?

Findings In this cohort study of 801 hospital health care workers (HCWs), the risk of getting infected with SARS-CoV-2 was nearly 4-fold higher among HCWs on COVID-19 wards compared with HCWs not in patient care. Combined phylogenetic and epidemiological analyses found no patient-to-HCW transmission but several occurrences of HCW-to-HCW transmission.

Meaning These findings suggest that transmission of SARS-CoV-2 between HCWs deserves more consideration in infection prevention practice.

+ Supplemental content

Author affiliations and article information are listed at the end of this article.

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Abstract (continued)

transmission. These findings suggest that infection among HCWs deserves more consideration in infection prevention practice.

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Introduction

In 2020, health care institutions worldwide were overwhelmed by large numbers of patients with COVID-19. Stringent infection prevention and control measures have been applied to prevent transmission from patients to health care workers (HCWs) and from HCWs to HCWs. Nonetheless, HCWs have become infected during provision of care for patients with COVID-19, and there is ongoing debate concerning transmission dynamics¹ and which infection prevention and control measures are adequate.²⁻⁴ Delivering direct care to patients with COVID-19 has been associated with infection or COVID-19-related hospital admission among HCWs in some⁵⁻⁹ but not all studies.¹⁰⁻¹⁴ Most studies were cross-sectional and retrospective and lacked predefined control groups and detailed information on SARS-CoV-2 exposure, including use of personal protective equipment (PPE).

To quantify the incidence of SARS-CoV-2 infection among HCWs, identify potential risk factors associated with infection, and elucidate potential transmission routes, we performed the Serologic Surveillance of SARS-CoV-2 Infection in Health Care Workers (S3) study in 2 tertiary care medical centers in the Netherlands. Participants were working during the first wave of SARS-CoV-2 infections. Serial serologic measurements and epidemiological data were combined with phylogenetic analysis of viruses isolated from patients and HCWs to identify transmission clusters.

Methods

Study Design and Population

We conducted a prospective serologic surveillance cohort study among HCWs of the Amsterdam University Medical Centers in the Netherlands, which comprises 2 tertiary care hospitals. Measurements of SARS-CoV-2-specific antibodies were taken every 4 weeks over 18 weeks during the first COVID-19 wave (ie, March 23-June 25, 2020). The first patient with a confirmed COVID-19 diagnosis was admitted on March 9. Enrolment of HCWs took place from March 23 to April 7 except for HCWs in non-COVID-19 care, who were enrolled during the final measurement, in June 2020. Phlebotomies were combined with surveys, which included questions on personal and work-related SARS-CoV-2 exposure and symptoms. Recruitment of HCWs was done by leaflets distributed in relevant departments with potentially eligible HCWs and by intranet news items. Participants were invited for and reminded of follow-up measurements by email.

Potential participants were eligible for inclusion in 1 of 3 specific groups based on exposure to patients with COVID-19: (1) HCWs working as nurses or physicians with bedside contacts with patients with COVID-19 on designated regular-care COVID-19 wards, emergency departments (EDs), or intensive care units (ICUs); (2) HCWs working as nurses or physicians on wards designated for non-COVID-19 care; and (3) HCWs not working in patient care. The second group participated in only the final measurement.

This study was reviewed and approved by institutional review boards of both hospitals, and written informed consent was obtained from each participant. The study report follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.

Infection Prevention Practices

The tertiary care centers instituted identical infection prevention and control measures in accordance with European and national guidelines.^{15,16} Initially, all HCWs caring for patients suspected of having COVID-19 used PPE consisting of disposable nonsterile gloves, gowns, FFP2 masks (which are considered equivalent to N95 masks), and reusable goggles.¹⁷ From March 16 onward, national guidelines on PPE were adjusted in accordance with recommendations at the time.^{15,16} Type IIR surgical masks were used during non-aerosol-generating care, and FFP2 masks were used during intensive care and high-risk, aerosol-generating procedures (ie, high-flow nasal oxygen therapy, noninvasive ventilation, intubation, bronchoscopy, and nebulized medication). No PPE was recommended outside direct care of patients with COVID-19, but social distancing measures were implemented through the hospitals (eg, keeping 1.5 m of distance between individuals, conducting no meetings with >30 people or with external visitors, and closing sitting areas in restaurants). Additional details regarding infection practices are provided in eMethods in the [Supplement](#).

Procedures

We collected survey data using Castor Electronic Data Capture version 2020.1 (Castor).¹⁸ A survey example is provided in eMethods in the [Supplement](#). At each measurement, participants reported results of any preceding SARS-CoV-2 nucleic acid amplification test (NAAT) of nasopharyngeal swabs, which were performed as part of routine hospital testing of symptomatic HCWs. Measurement in serum of SARS-CoV-2-specific antibodies was done using the Wantai SARS-CoV-2 pan-immunoglobulin anti-S1-receptor-binding domain test according to the manufacturer's instructions (Beijing Wantai Biological Pharmacy enzyme-linked immunosorbent assay [ELISA], Bioscience chemiluminescence immunoassay, and Zhuhai Livzon ELISA).¹⁹ Indeterminate results were classified as negative.

Outcomes

The primary outcomes were cumulative incidence of and time to SARS-CoV-2 infection during the study period. Infection with SARS-CoV-2 was defined as presence of SARS-CoV-2-specific antibodies above the threshold set by the manufacturer. The date of SARS-CoV-2 infection was defined as the sampling date of a first positive NAAT result or, in its absence, the midpoint between the last seronegative and the first seropositive sample. All participants were assumed to be seronegative on February 27, which was 4 weeks before the first measurement and the day of the first diagnosis of COVID-19 in the Netherlands.

Outcomes were compared among the 3 study groups. Subgroup analysis included comparisons between hospital unit types (ie, COVID-19 ward, ICU, and ED) and profession (ie, nurse and physician). Secondary outcomes included results of phylogenetic analyses and infection rates by self-reported exposure to patients with COVID-19, number of household contacts with COVID-19, and presence of COVID-19-associated symptoms

Viral Sequencing and Phylogenetic Analyses

To identify possible transmission clusters, virus sequencing was performed from routinely stored nasopharyngeal swabs of 26 HCWs who were infected (including study participants and others) and 39 patients with COVID-19. These HCWs and patients were selected from COVID-19 wards with the highest incidence of infection among HCWs from which the largest number of temporally associated patient samples were also available. Included HCWs worked on COVID-19 wards from March 15 to May 15; included patients had been admitted to corresponding wards from March 13 to April 19. Complete viral genomes were sequenced using the Ion AmpliSeq SARS-CoV-2 Research Panel, Ion Chef, and Ion Torrent S5 platforms (all Thermo Fisher Scientific). Consensus full-length SARS-CoV-2 genomes (ie, >29 000 nucleotide bases long with minimum depth of coverage for each site of 100 bases) were generated by removing reads ends with Phred quality scores of less than 20 using

Trimmomatic version 0.39 and mapping raw reads against the WIV04 reference genome (GenBank reference MN996528.1) using Bowtie 2 version 2.4.1.²⁰⁻²²

We used Mafft version 7.427 (Research Institute for Microbial Diseases) to align SARS-CoV-2 sequences from HCWs and patients, together with 300 randomly selected, contemporaneous SARS-CoV-2 virus genomes from the Netherlands (see eAppendix in the [Supplement](#) for Global Initiative on Sharing Avian Influenza Data [GISAID] accession numbers).²³ We inferred a maximum likelihood tree with IQ-Tree version 2.0.6 (Minh et al²⁴) using the Hasegawa-Kishino-Yano (HKY) + proportion of invariable sites (I) + gamma-distributed rate variation among sites (G) model. We applied Phydelity version 1 (Han et al) to the maximum likelihood tree to infer putative transmission clusters.²⁵

We used Bayesian Evolutionary Analysis Sampling Trees (BEAST) version 1.10.4 (BEAST Developers) to reconstruct a bayesian time-scaled phylogenetic tree for the same set of sequences using the HKY + I + G model with a strict molecular clock, an exponential growth prior, and an informative clock prior based on recent estimates of SARS-CoV-2 substitution rate (Γ distribution prior with a mean of 0.8×10^{-3} substitutions/site/y and an SD of 5×10^{-4}).^{26,27} We performed and combined 2 chains of 100 million steps. Convergence was reached for all parameters (effective sample size > 700).

Statistical Analysis

We used Kaplan-Meier estimates with log-rank test and univariable and multivariable Cox regression analyses to compare SARS-CoV-2 infection over time between study groups. The proportional hazard assumption did not hold because of fluctuating incidence of COVID-19 during the study period, evidenced by Schoenfeld tests resulting in $P < .05$. The reported hazard ratios [HRs] should therefore be interpreted as mean relative hazards for the entire study period instead of a relative hazard at each individual time point. Multivariable models contained all other covariates used in the univariable models; these covariates were selected based on clinical relevance. Analysis was based on individuals with complete data on covariates included in the regression models. Hypothesis testing was 2-sided, and results were considered statistically significant when 95% CIs did not cross 1. R statistical software version 4.0.3 (R Project for Statistical Computing) was used for all other analyses. Data were analyzed from August through December 2020.

Results

Participants

Among 801 HCWs, there were 439 HCWs in the COVID-19 care group, 164 HCWs in the non-COVID-19 care group, and 198 HCWs in the no patient care group. We excluded 1 additional participant during the first measurement because this individual did not meet inclusion criteria. Median (interquartile range [IQR]) age was 36 (29-50) years, and there were 580 (72.4%) women. The HCWs providing COVID-19 and non-COVID-19 care were younger than HCWs not working in patient care (median [IQR] age, 34 [29-44] years and 33 [27-49], respectively, vs 49 [40-57] years) (**Table 1**). Median [IQR] follow-up duration was 120 [92-120] days with a maximum of 120 days. For measurements 2 through 4, survey completion rates were higher than the rate of HCWs complying with blood sampling, which was likely associated with measurements 2 through 4 not requiring physical presence. None of the participants with a SARS-CoV-2 infection reported being hospitalized during the study period (eTable 1 in the [Supplement](#)).

Primary Outcome

Cumulative incidence of SARS-CoV-2 was increased among HCWs working in COVID-19 care (54 HCWs [13.2%; 95% CI, 9.9%-16.4%]) compared with HCWs in non-COVID-19 care (11 HCWs [6.7%; 95% CI, 2.8%-10.5%]; HR, 2.25; 95% CI, 1.17-4.30) and in HCWs not working in patient care (7 HCWs [3.6%; 95% CI, 0.9%-6.1%]; HR, 3.92; 95% CI, 1.79-8.62) (**Figure 1A**; **Table 2**). Among HCWs caring

for patients with COVID-19, SARS-CoV-2 cumulative incidence was increased among HCWs working on COVID-19 wards (32 of 134 HCWs [25.7%; 95% CI, 17.6%-33.1%]) compared with HCWs working on ICUs (13 of 186 HCWs [7.1%; 95% CI, 3.3%-10.7%]; HR, 3.64; 95% CI, 1.91-6.94) and HCWs working in EDs (7 of 102 HCWs [8.0%; 95% CI, 2.5%-13.1%]; HR, 3.29; 95% CI, 1.52-7.14) (Figure 1B; Table 2). The number of COVID-19 admissions to study hospitals and regional COVID-19 incidence are shown in eFigure 1 in the Supplement. Results were similar for individual study sites (eFigure 2A and B and

Table 1. General Characteristics of Participants

Characteristic, No. (%) ^a	COVID-19 care (n = 439)	Non-COVID-19 care (n = 164)	No patient care (n = 198)
Age, median (IQR)	34 (29-44)	33 (27-49)	49 (40-57)
Sex ^b			
Women	289 (70.3)	145 (88.4)	146 (76.4)
Men	122 (29.7)	19 (11.6)	45 (23.6)
Position			
Nurse	219 (49.9)	129 (78.7)	0
Resident	107 (24.4)	25 (15.2)	0
Specialist	86 (19.6)	10 (6.1)	0
Other patient care	27 (6.2)	0	0
Administration or policy	0	0	62 (31.3)
Scientist	0	0	43 (21.7)
Pharmacy	0	0	17 (8.6)
Other nonpatient care	0	0	76 (38.4)
Tertiary care center			
Amsterdam University Medical Centers, location Academic Medical Center	253 (57.6)	73 (44.5)	84 (42.4)
Amsterdam University Medical Centers, location Vrije Universiteit University Medical Center	186 (42.4)	91 (55.5)	114 (57.6)
Days/week spent in hospital, mean (range)	4.1 (1-5.5)	3.8 (2-5.5)	2.9 (1-5.5)
Serology test result			
Ever positive	54 (12.3)	11 (6.7)	7 (3.5)
PCR test result			
Ever positive	27 (6.2)	7 (4.3)	0
Always negative	165 (37.6)	58 (35.4)	20 (10.1)
Never tested	247 (56.3)	99 (60.4)	178 (89.9)
PPE training followed			
Electronic learning only	160 (36.6)	65 (39.6)	NA
Simulation only	13 (3)	3 (1.8)	NA
Both	253 (57.9)	92 (56.1)	NA
None	11 (2.5)	4 (2.4)	NA
Feasibility of social distancing			
Easy	2 (0.5)	11 (6.7)	42 (21.9)
Medium	27 (6.5)	11 (6.7)	56 (29.2)
Difficult	111 (26.6)	46 (28)	69 (35.9)
Virtually impossible	278 (66.5)	96 (58.5)	25 (13)
Worried about getting COVID-19			
Not at all	117 (33.9)	102 (62.2)	52 (29.7)
Somewhat	164 (47.5)	37 (22.6)	92 (52.6)
Medium	53 (15.4)	16 (9.8)	26 (14.9)
Very	11 (3.2)	9 (5.5)	5 (2.9)
If worried, most worried about			
Personal health	53 (23.3)	17 (27.4)	28 (22.8)
Infecting friends or family	156 (68.7)	40 (64.5)	90 (73.2)
Infecting patients	18 (7.9)	5 (8.1)	0
Infecting colleagues	0	0	5 (4.1)

Abbreviations: IQR, interquartile range; NA, not applicable; PCR, polymerase chain reaction; PPE, personal protective equipment.

^a Data are from a survey among health care workers.

^b Information on sex was missing for 35 participants because they did not participate in measurement 2, when this was asked as part of the survey.

eFigure 3A and B in the [Supplement](#)) and when including only NAAT or only serology results in the analysis (eFigure 2C and D and eFigure 3C and D in the [Supplement](#)). Main results were similar after adjustment in multivariable Cox regression.

Contact with an individual from the community (including the household) with COVID-19 (HR, 2.60; 95% CI, 1.55-4.35) and contact with a coworker with COVID-19 (HR, 2.02; 95% CI, 1.26-3.24) were associated with increased risk of COVID-19 infection (Table 2). Among 437 HCWs providing COVID-19 care, 426 HCWs (97.4%) followed training on the use of PPE. Self-reported adherence to PPE guidelines was mixed (131 of 138 HCWs on ICUs [94.9%], 133 of 149 HCWs on COVID-19 wards [89.3%], and 95 of 119 HCWs on EDs [79.8%]) but was not associated with SARS-CoV-2 incidence.

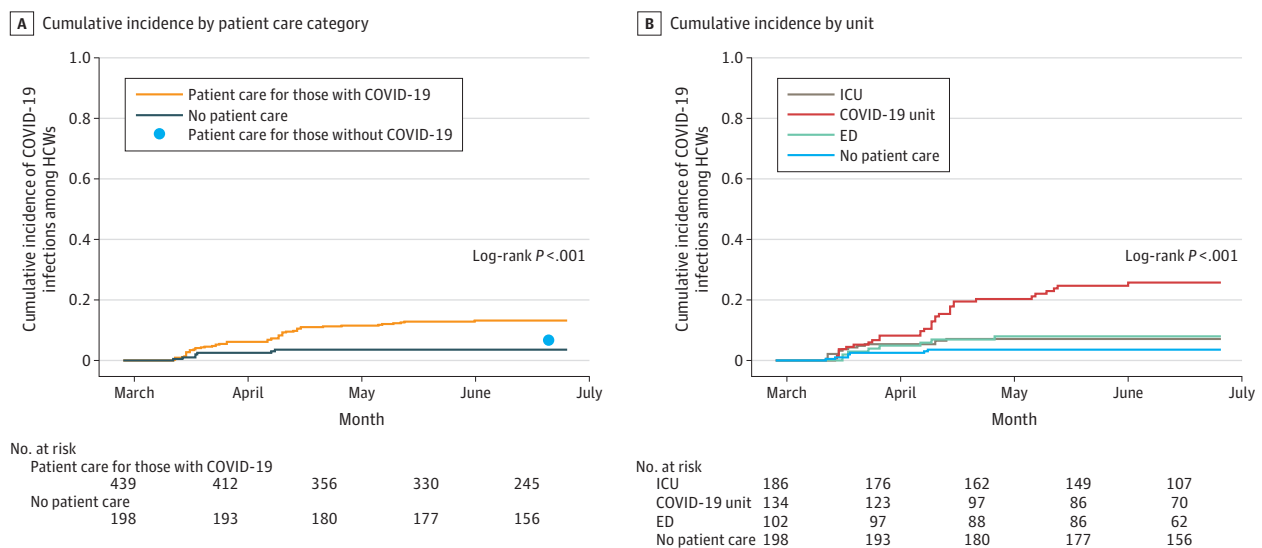
Among HCWs working in COVID-19 care, cumulative incidence among physicians was 19 individuals (11.0%; 95% CI, 6.3%-15.5%); specialists had decreased cumulative incidence compared with residents (5 individuals [6.4%; 95% CI, 0.7%-11.8%] vs 14 individuals [14.7; 95% CI, 10.2%-19.3%]; HR, 2.70; 95% CI, 0.98-7.42) and nurses (35 individuals [14.9%; 95% CI, 10.2%-19.3%]; HR, 2.58; 95% CI, 1.01 to 6.59).

Incidence of SARS-CoV-2 among HCWs was increased on 1 regular COVID-19-ward (ward 2) compared with other COVID-19 wards (eFigure 4 in the [Supplement](#)). This ward was similar to the other wards with regard to HCW deployment and architectural structure but had an increased proportion of patients with preexisting pulmonary disease and use of high-flow nasal oxygen therapy. To assess the contribution of this ward to overall results, the primary outcome was reanalyzed when excluding this ward, and we found a SARS-CoV-2 incidence among HCWs on COVID-19 units of 22 of 118 HCWs (19.7%; 95% CI, 12.0%-26.8%) (compared with HCWs on ICUs: HR, 2.78; 95% CI, 1.40-5.52) (eTable 2 in the [Supplement](#)).

Secondary Outcomes

Among 72 participants with seroconversion, 33 participants (45.8%) also tested positive by NAAT during routine screening of symptomatic HCWs. Because of the restrictive access to SARS-CoV-2 testing at that time, all of these individuals were HCWs in direct patient care. There was 1 participant without documented seroconversion who tested positive by NAAT, which occurred prior to the fourth measurement. However, the subsequent blood sample was mislabeled and therefore not analyzed.

Figure 1. Cumulative Incidence of COVID-19 Among Health Care Workers (HCWs)



ED indicates emergency department; ICU, intensive care unit.

Among 72 HCWs with SARS-CoV-2 infection, 61 HCWs (84.7%) reported at least 1 symptom suggestive of COVID-19 (ie, cough, headache, sore throat, fever, dyspnea, chest pain, anosmia, cold, diarrhea) compared with 630 of 729 participants (86.4%) without infection. After adjustment for other symptoms, anosmia was associated with increased risk of infection: 39 of 72 participants who

Table 2. Univariable and Multivariable Cox Regression Analysis of Factors Associated With SARS-CoV-2 Infection

Factor ^a	SARS-CoV-2 incidence, No./total No. (%; 95% CI) ^b	HR (95% CI)	Adjusted HR (95% CI) ^c
Overall study population			
HCW work environment			
No patient care	7/198 (3.6; 0.9-6.1)	1 [Reference]	1 [Reference]
Non-COVID-19 care only	11/164 (6.7; 2.8-10.5)	1.75 (0.68-4.51)	1.59 (0.58-4.37)
COVID-19 care	54/439 (13.2; 9.9-16.4)	3.92 (1.79-8.62) ^d	3.08 (1.23-7.66) ^d
Contact with coworker with COVID-19			
No	30/455 (7.0; 4.5-9.4)	1 [Reference]	1 [Reference]
Yes	40/319 (13.5; 9.5-17.3)	2.02 (1.26-3.24)	1.71 (0.99-2.97)
Contact with community member with COVID-19			
No	52/693 (8.2; 6.0-10.3)	1 [Reference]	1 [Reference]
Yes	20/108 (20.2; 11.8-27.9)	2.60 (1.55-4.35)	2.03 (1.14-3.62)
Days per week spent in hospital	NA	1.07 (0.84-1.35)	1.71 (0.99-2.97)
Age	NA	0.98 (0.96-0.997)	0.99 (0.97-1.01)
Within care of patients with COVID-19			
Hospital unit type			
ICU	13/186 (7.1; 3.3-10.7)	1 [Reference]	1 [Reference]
COVID-19 unit	32/134 (25.7; 17.6-33.1)	3.64 (1.91-6.94) ^e	3.71 (1.66-8.29) ^e
ED	7/102 (8.0; 2.5-13.1)	1.11 (0.46-2.67)	1.29 (0.46-3.61)
Combination	2/17 (11.9; 0-25.8)	2.03 (0.46-9.03)	1.21 (0.12-11.77)
Position			
Specialist	5/86 (6.4; 0.7-11.8)	1 [Reference]	1 [Reference]
Resident	14/107 (14.7; 7.5-21.3)	2.70 (0.98-7.42)	1.69 (0.50-5.67)
Nurse	35/246 (14.9; 10.2-19.3)	2.58 (1.01-6.59)	1.62 (0.57-4.60)
Self-reported COVID-19 exposure			
Low	13/88 (15.3; 7.3-22.7)	1 [Reference]	1 [Reference]
Medium	16/165 (11.2; 6.0-16.1)	0.65 (0.30-1.43)	0.50 (0.21-1.21)
High	13/73 (18.2; 8.7-26.6)	1.12 (0.52-2.42)	1.12 (0.43-2.90)
Very high	12/113 (10.8; 4.8-16.4)	0.66 (0.32-1.36)	0.77 (0.28-2.11)
Feasibility of social distancing			
Easy	0/2 (0; 0-0)	NA	NA
Medium	7/27 (26.7; 7.5-41.8)	1 [Reference]	1 [Reference]
Difficult	19/111 (18.5; 10.5-25.8)	0.60 (0.25-1.42)	0.42 (0.14-1.28)
Virtually impossible	26/278 (9.9; 6.3-13.4)	0.32 (0.14-0.73)	0.31 (0.11-0.90)
PPE always correctly used			
No	5/54 (9.4; 1.2-16.9)	1 [Reference]	1 [Reference]
Yes	49/383 (13.8; 10.2-17.3)	1.43 (0.57-3.59)	1.19 (0.41-3.45)
Contact with coworker with COVID-19			
No	17/186 (9.3; 5.0-13.5)	1 [Reference]	1 [Reference]
Yes	35/232 (16.0; 11.1-20.7)	1.71 (0.96-3.04)	2.36 (1.11-5.03)
Contact with community member with COVID-19			
No	39/360 (11.8; 8.2-15.1)	1 [Reference]	1 [Reference]
Yes	15/79 (19.7; 10.2-28.2)	1.80 (0.996-3.26)	1.46 (0.70-3.05)
Days per week spent in hospital	NA	0.70 (0.52-0.94)	0.66 (0.47-0.92)
Age, y	NA	0.97 (0.95-1.00)	1.00 (0.97-1.03)

Abbreviations: ED, emergency department; HCW, health care worker; HR, hazard ratio; ICU, intensive care unit; NA, not applicable; PPE, personal protective equipment.

^a Data are from a survey among health care workers.

^b Percentages with CIs were calculated using the Kaplan-Meier method.

^c Adjusted HRs are for models containing all variables for the overall study population and for HCWs providing care to patients with COVID-19, respectively.

^d Compared with care of patients without COVID-19 only: HR, 2.25; 95% CI, 1.17-4.30; adjusted HR, 1.93; 95% CI, 0.98-3.81.

^e Compared with ED: HR, 3.29; 95% CI, 1.52-7.14; adjusted HR, 2.9X; 95% CI, 1.2X-7.1X.

were seropositive (70.8%; 95% CI, 53.4%-81.7%) compared with 14 of 729 participants who were negative (4.5%; 95% CI, 3.0%-6.1%) (adjusted HR, 2.95; 95% CI 13.71-45.41).

Phylogenetic Analyses

In the maximum likelihood phylogeny, 32 of 39 sequences from patients admitted to a COVID-19 ward (**Figure 2A**) and 12 of 26 samples from HCWs were dispersed across the tree among 300 contemporaneous viruses from the Netherlands suggesting unrelated infections. Phydelity identified 5 putative transmission clusters containing the remaining 21 sequences (7 patients, 14 HCWs) (**Figure 2A**). Clusters A and B comprised patients clustering with each other or with HCWs. The 3 other transmission clusters (ie, C, D, and E) contained only HCWs.

Patient-to-patient and HCW-to-patient transmissions were unlikely because patients admitted to COVID-19 wards had NAAT-confirmed SARS-CoV-2 infection or were highly suspected of SARS-CoV-2 infection based on symptoms or radiological findings at time of admission. This is further evidenced by the lack of clear epidemiological links between patients in clusters A and B. There was additionally no evidence of patient-to-HCW transmission based on our phylogenetic analysis, and there was no overlap between the patient admission dates and HCW working shifts in clusters A and B (**Figure 2C**; eFigure 5 in the [Supplement](#)).

In 3 clusters containing only HCWs, there was a high degree of overlap in working shifts, suggesting epidemiological linkage (**Figure 2C**; eFigure 5 in the [Supplement](#)). In 2 clusters (ie, D and E), only sequences obtained from HCWs working in ward 2 were included. The time-scaled phylogeny (**Figure 2B**) suggests a single introduction for these HCWs working in ward 2 at approximately mid-March (median date, March 19, 2020; 95% highest posterior density interval: March 11-March 30, 2020; 100% posterior support).

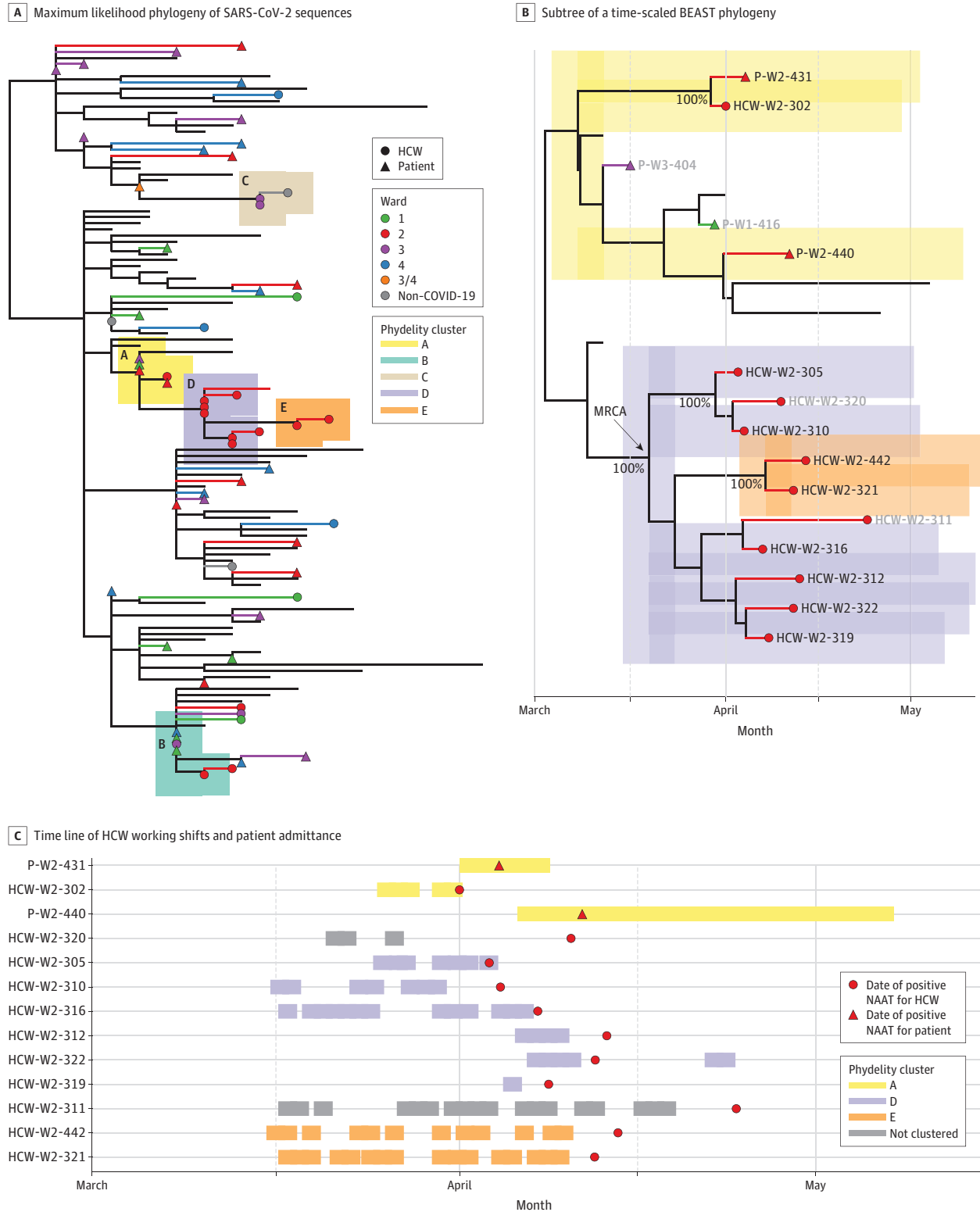
Discussion

In this cohort study, we prospectively followed a large cohort of HCWs during the first wave of the COVID-19 pandemic with the aim of comparing cumulative SARS-CoV-2 incidence between groups of HCWs with varying exposure to patients with COVID-19. We found a consistently increased risk of SARS-CoV-2 infection among HCWs caring for patients with COVID-19 compared with HCWs working in non-COVID-19 care and HCWs not working in patient care. In subgroup analysis, we found that the overall risk was largely associated with a substantially increased risk among HCWs on regular-care COVID-19 wards; infection rates among HCWs working in ICUs and EDs were similar to those among HCWs working in non-COVID-19 care. Our phylogenetic analysis combined with epidemiologic data identified transmission clusters comprising only HCWs, consistent with HCW-to-HCW transmission on COVID-19 wards, while no evidence of patient-to-HCW transmission was found.

Seroprevalence of SARS-CoV-2 among HCWs not working in patient care was similar to that of healthy blood donors in the Dutch general population at the time.²⁸ The increased incidence among HCWs working in patient care of any kind suggests that working in patient care is associated with increased infection risk. Incidence of infection was highest among HCWs working in COVID-19 care, which may suggest that patient-to-HCW transmission was associated with the excess incidence in this group. However, we did not find an association between self-reported number of contacts who had COVID-19 and infection or between self-reported use of PPE and infection, which would have been expected if patient-to-HCW transmission was the dominant transmission pattern. Additionally, on 1 of 6 COVID-19 wards, multiple HCWs were infected before the first patient with COVID-19 was admitted. In the phylogenetic analyses, we also found no evidence for patient-to-HCW transmission, although this cannot be completely ruled out, given that nasopharyngeal samples were not available for all relevant patients or HCWs.

In phylogenetic analyses, we found evidence for HCW-to-HCW transmission on COVID-19 units. The hypothesis that HCW-to-HCW transmission played an important role was further supported by the increased incidence among HCWs who reported contact with a colleague who was SARS-CoV-2

Figure 2. SARS-CoV-2 Sequence Phylogeny



BEAST indicates Bayesian Evolutionary Analysis Sampling Trees; HCW, health care worker; MRCA, most recent common ancestor; and NAAT, nucleic acid amplification test.

positive. More than half of HCWs who were seropositive in our study did not report a positive NAAT result, suggesting that a significant proportion of infections among HCWs remained unrecognized. This suggests that HCWs likely have been working while unaware of their SARS-CoV-2 infections, hence presenting a risk of transmission. The number of HCWs present on COVID-19 wards was increased compared with other regular-care wards owing to the nature of care and because mobility of HCWs working in COVID-19 care through the hospital was discouraged. Personnel break rooms on COVID-19 wards were therefore more crowded than usual and more crowded than on non-COVID-19 care wards because of downscaling of regular care. While universal masking was not yet recommended during this period, it is arguable whether this would have made a difference in transmission in break rooms (or other places where HCWs would take breaks, eat, or drink) because masks cannot be worn while eating or drinking. The ICUs differed with regard to facilitating social distancing by using additional break rooms with clearly demarcated spaces between seats.

Preventing SARS-CoV-2 infection among HCWs is important to maintain the health of the individual HCW, to halt the ongoing pandemic, and to maintain a functioning health care system. Understandably, much attention has been focused on preventing patient-to-HCW transmission. Our results show that working in hospital patient care leaves HCWs at risk of infection through HCW-to-HCW transmission, which has received less attention and may deserve more consideration. We recommend in the current situation of high SARS-CoV2 incidence using optimal measures to facilitate social distancing on the work floor. These could include reducing the number of people per room by spreading out break times, increasing the size or number of break rooms, enabling online conferencing, recommending universal use of face masks, and investing in structural auditing and training by infection prevention and control personnel.

Limitations

Our study has several limitations. First, despite the prospective cohort design, selection bias cannot be completely ruled out; for example, HCWs staying at home ill were not able to enroll if the absence happened during the first measurement, which may have resulted in underestimating of incidence. Second, not all nasopharyngeal samples from patients or HCWs collected for SARS-CoV-2 NAAT were available for viral sequencing analyses because they were not stored or the admitted patients were diagnosed elsewhere. Therefore, there may be missing clusters or missing links in the transmission clusters that were inferred. Third, no systematic data on compliance to infection prevention measures were collected, limiting more precise conclusions. Fourth, infection incidence was substantially increased on 1 COVID-19 ward, which also contributed most transmission clusters. This ward was the only non-ICU ward to use high-flow nasal oxygen therapy, which may have been associated with increased rates of patient-to-HCW transmission. However, we found no evidence for this in the transmission analysis so although a causative role cannot be completely excluded, it is unlikely to have played a major role. Importantly, when excluding this ward from the analysis, the proportion of HCWs who were seroconverted on regular COVID-19 wards remained more than 2-fold that found for ICUs. Fifth, although specificity of the Wantai serologic assay is reportedly high (99.3%), sensitivity is lower (85.2%, >15 days after symptom onset), so some false-negative results may have occurred.¹⁹ However, our repeated measurement design and the availability of NAAT results may have decreased the potential occurrence of such misclassification.

Conclusions

These findings suggest that HCWs working on COVID-19 wards are at increased risk for nosocomial SARS-CoV-2 infection. Our results further suggest an important role for HCW-to-HCW transmission.

ARTICLE INFORMATION

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Corresponding Author: Jonne J. Sikkens, MD, PhD, Department of Internal Medicine, Amsterdam Infection and Immunity Institute, Amsterdam University Medical Centers, Vrije Universiteit Amsterdam, De Boelelaan 1117, 1081HV, Noord Holland, the Netherlands (j.sikkens@amsterdamumc.nl).

Author Affiliations: Department of Internal Medicine, Amsterdam Infection and Immunity Institute, Amsterdam University Medical Centers, Vrije Universiteit Amsterdam, Amsterdam, the Netherlands (Sikkens, Buis, Lavell, Smulders); Section Infectious Diseases, Department of Internal Medicine, Amsterdam Infection and Immunity Institute, Amsterdam University Medical Centers, Vrije Universiteit Amsterdam, Amsterdam, the Netherlands (Peters, Bomers); Department of Medical Microbiology and Infection Prevention, Amsterdam Infection and Immunity Institute, Amsterdam University Medical Centers, Vrije Universiteit Amsterdam, Amsterdam, the Netherlands (Dekker); Center for Experimental Molecular Medicine, Amsterdam Infection and Immunity Institute, Amsterdam University Medical Centers, University of Amsterdam, Amsterdam, the Netherlands (M. Schinkel, Reijnders, Schuurman, de Brabander); Department of Occupational Health and Safety, Amsterdam University Medical Centers, University of Amsterdam, Amsterdam, the Netherlands (Maas); Department of Medical Microbiology and Infection Prevention, Amsterdam University Medical Centers, University of Amsterdam, Amsterdam, the Netherlands (Koopse, Han, Russell, J. Schinkel, Jonges, Matamoros, Jurriaans, van Mansfeld, de Jong); Division of Infectious Diseases, Department of Internal Medicine, Amsterdam Infection and Immunity Institute, Amsterdam University Medical Centers, University of Amsterdam, Amsterdam, the Netherlands (Wiersinga).

Author Contributions: Drs Sikkens and Bomers had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Concept and design: Sikkens, Buis, Peters, Dekker, Schuurman, Russell, Wiersinga, Smulders, de Jong, Bomers.

Acquisition, analysis, or interpretation of data: All authors.

Drafting of the manuscript: Sikkens, Maas, Koopse, Han, Jonges, Bomers.

Critical revision of the manuscript for important intellectual content: Sikkens, Buis, Peters, Dekker, M. Schinkel, Reijnders, Schuurman, Brabander, Lavell, Koopse, Han, Russell, J. Schinkel, Matamoros, Jurriaans, Mansfeld, Wiersinga, Smulders, de Jong, Bomers.

Statistical analysis: Sikkens, Buis, Reijnders, Koopse, Han, Russell, J. Schinkel, Jonges, Matamoros, Smulders, Bomers.

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SUPPLEMENT.

eMethods.

eAppendix. Viral Genome Data Acknowledgement

eFigure 1. COVID-19 Hospital and Intensive Care Admissions and Regional COVID-19 Incidence

eFigure 2. Cumulative Incidence of SARS-CoV-2 Infection Among Health Care Workers With by Exposure to Patients With COVID-19

eFigure 3. Cumulative Incidence of SARS-CoV-2 Infection Among Health Care Workers With by Hospital Unit Type

eFigure 4. Cumulative Incidence of SARS-CoV-2 Infection Among Health Care Workers per Specific COVID-19 Regular Ward

eFigure 5. Working Shifts and Admittance Dates of Individuals Identified in Each Transmission Cluster

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Several hundred Virginia health-care workers have been suspended or fired over coronavirus vaccine mandates

By Jenna Portnoy

October 3, 2021 at 6:00 a.m. EDT



Several hundred hospital workers in Virginia have been suspended or lost their jobs because they refused to get vaccinated against the coronavirus, as required by most major health-care systems.

The earliest vaccine mandates went into effect Sept. 1, with two other waves set for Oct. 18 and Nov. 1, according to a survey of hospital policies.

Across the country, health-care systems that have instituted mandates have seen some workers leave or be terminated over their refusal to get the shot, exacerbating a shortage in skilled nursing and bedside care.

Health-care systems in rural areas of Virginia, where there is generally more vaccine resistance, are being hit harder by an employee exodus over mandates than urban and suburban hospitals, which generally have larger staffs and are better able to withstand some unvaccinated employees leaving.

Inova in Northern Virginia lost 89 workers for noncompliance with the system's requirement, which is less than half of 1 percent of its workforce, while Valley Health, based in the northern Shenandoah Valley, fired a little over 1 percent of its workers for not getting a vaccine.

Hospital officials say the reasons that workers refuse to get vaccinated mirror hesitancy in the larger community, especially in rural counties, including historical distrust of medical institutions and worries about the development of the vaccine technology.

Some area health systems have opted not to require vaccination against the coronavirus, for fear too many workers would leave over it. Alan Levine, the CEO of Ballad Health, estimated a mandate would cost Ballad 5 to 10 percent of its staff; about 63 percent of its staff are already vaccinated, which is higher than the southwest Virginia and northeast Tennessee communities the system serves.

"In a rural hospital it doesn't take a whole lot of people to walk away for it to have a serious effect on your hospital," Levine said. "It's a lot easier to recruit nurses to Northern Virginia than it is to Southwest Virginia."

As a result, many officials are considering a policy where unvaccinated workers contribute more to their health insurance. "Perhaps it's a choice but it comes with a financial consequence," he said.

Ballad, which recently reinstated a policy of postponing elective surgeries, hit its peak of 413 in-house covid patients last month, including 120 in the ICU, most of whom were on ventilators, he said. By Friday, the number was down to about 300, Levine said.

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In contrast, J. Stephen Jones, the president and CEO of Inova, which operates the state's largest hospital, Inova Fairfax, said the Northern Virginia system's Sept. 1 vaccine mandate helped with recruitment. Jones said that nurses in the urban and suburban hospitals want to know they are working with vaccinated colleagues out of concern for their own safety.

Still, of 20,000 Inova employees, 89 left as of last week because they would not get vaccinated.

"First and foremost, vaccination mandates work," Jones said in an interview. "Recognizing that people are dying by the thousands, mandates are going to have to be the solution to get us beyond this."

Before vaccines were available, several hundred workers at a time could be isolating due to being ill with covid-19 or having had a coronavirus exposure, but Jones said as of Friday, only 20 workers were out with covid-19 and none were hospitalized.

"The mandate is based on very strong, extremely clear guidance on the safety and efficacy of the vaccine," he said.

Officials at Valley Health, a health-care system that operates Winchester Medical Center and serves the northern Shenandoah Valley, said 72 employees were terminated on Sept. 21, for noncompliance with the Sept. 7 vaccine mandate.

The system granted about 300 employees — or 5 percent of its 6,000 workers — a religious or medical exemption from the mandate, officials said.

Jeff Feit, vice president for community and population health at Valley Health, declined to detail why people requested exemptions, but said the confidential process was "rigorous and consistent."

In mid-August, about 20 people, many of them nurses, stood outside Winchester Medical Center to protest the requirement. A judge last week dismissed a lawsuit filed by three unvaccinated employees of the hospital who wanted to keep their jobs despite the mandate, the Northern Virginia Daily reported.

"I'm very respectful that this was a hard decision for a lot of people, but it was their decision," Feit said of the mandate in general. "It's wonderful to live in a country where we have free choice."

The D.C. Hospital Association, which expressed support in June for mandatory vaccination as a condition of employment, said in a statement that hospitals in the city had seen "tremendous" upticks in vaccinations among licensed and unlicensed hospital staff in recent weeks, particularly among those who have been hesitant. The city mandated vaccination for all health-care workers in D.C. by Sept. 30, unless they had a religious or medical exemption.

"While hospital policies vary, some of our members will begin taking employment actions in accordance with their policies on October 1," the statement said. "DC hospitals do not take these actions lightly. The singular objective of our member hospitals is to ensure a safe environment to work and care for patients, and vaccination is key to that goal."

Here's where major area health systems stand with vaccine mandates:

- **Virginia Hospital Center** in Arlington does not have a vaccine mandate, but about 92 percent of employees are already fully vaccinated, spokeswoman Maryanne Boster said.
- **VCU Health System** required employees to get their first dose by Sept. 15.
- Four systems serving Virginia's Hampton Roads region — **Sentara Healthcare, Chesapeake Regional Healthcare, Children's Hospital of The King's Daughters Health System** and **Riverside Health System** — require employees to be vaccinated by Oct. 18. Of 28,000 Sentara employees, 13 people have resigned due to the

vaccine requirement, spokeswoman Kelly Kennedy said.

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- **UVA Health** requires all employees to be fully vaccinated by Nov. 1. As of Friday morning, the system had 66 employees on paid administrative leave for a coronavirus infection or exposure, spokesman Eric Swensen said.

- **Johns Hopkins Medicine** required clinical and nonclinical personnel to be fully vaccinated by Sept. 1.

- **Luminis Health**, which operates Doctors Community Hospital in Lanham and Anne Arundel Medical Center, had an Oct. 1 deadline and said it will have more information about compliance among its 6,700 employees next week. But as of Friday, spokesman Justin McLeod said 2 percent, or about 134 workers, were not vaccinated.

- **University of Maryland Medical System** also set an Oct. 1 vaccine requirement deadline, and officials said Friday that 98 percent of full-time and part-time clinical staff and 96 percent of nonclinical staff were vaccinated. The system has nearly 30,000 workers.

- **Children's National Hospital** in June was one of the first children's hospitals in the nation to announce a vaccine mandate, which went into effect Sept. 30. All 8,500 employees are vaccinated and no one lost their job over the requirement, spokeswoman Diane Troese said.

- **United Medical Center** spokeswoman Toya S. Carmichael said every health-care worker in D.C. was required to receive at least the first dose of a vaccine by Sept. 30, and she said 86 percent of staff are fully vaccinated. Unvaccinated staff have until Oct. 30 to obtain a waiver from D.C. Health, she said.

- **MedStar Health** says all employees must be fully vaccinated by Nov. 1.

Michael Brice-Saddler contributed to this report.

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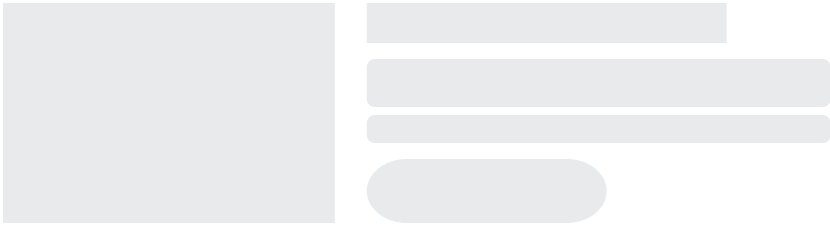
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Short-term and Long-term Rates of Postacute Sequelae of SARS-CoV-2 Infection A Systematic Review

Destin Groff, BA; Ashley Sun, BA; Anna E. Ssentongo, DrPH, MPH; Djibril M. Ba, PhD, MPH; Nicholas Parsons, MPhil; Govinda R. Poudel, PhD; Alain Lekoubou, MD, MSc; John S. Oh, MD; Jessica E. Ericson, MD, MPH; Paddy Ssentongo, MD, PhD, MPH; Vernon M. Chinchilli, PhD

Abstract

IMPORTANCE Short-term and long-term persistent postacute sequelae of COVID-19 (PASC) have not been systematically evaluated. The incidence and evolution of PASC are dependent on time from infection, organ systems and tissue affected, vaccination status, variant of the virus, and geographic region.

OBJECTIVE To estimate organ system-specific frequency and evolution of PASC.

EVIDENCE REVIEW PubMed (MEDLINE), Scopus, the World Health Organization Global Literature on Coronavirus Disease, and CoronaCentral databases were searched from December 2019 through March 2021. A total of 2100 studies were identified from databases and through cited references. Studies providing data on PASC in children and adults were included. The Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines for abstracting data were followed and performed independently by 2 reviewers. Quality was assessed using the Newcastle-Ottawa Scale for cohort studies. The main outcome was frequency of PASC diagnosed by (1) laboratory investigation, (2) radiologic pathology, and (3) clinical signs and symptoms. PASC were classified by organ system, ie, neurologic; cardiovascular; respiratory; digestive; dermatologic; and ear, nose, and throat as well as mental health, constitutional symptoms, and functional mobility.

FINDINGS From a total of 2100 studies identified, 57 studies with 250 351 survivors of COVID-19 met inclusion criteria. The mean (SD) age of survivors was 54.4 (8.9) years, 140 196 (56%) were male, and 197 777 (79%) were hospitalized during acute COVID-19. High-income countries contributed 45 studies (79%). The median (IQR) proportion of COVID-19 survivors experiencing at least 1 PASC was 54.0% (45.0%-69.0%; 13 studies) at 1 month (short-term), 55.0% (34.8%-65.5%; 38 studies) at 2 to 5 months (intermediate-term), and 54.0% (31.0%-67.0%; 9 studies) at 6 or more months (long-term). Most prevalent pulmonary sequelae, neurologic disorders, mental health disorders, functional mobility impairments, and general and constitutional symptoms were chest imaging abnormality (median [IQR], 62.2% [45.8%-76.5%]), difficulty concentrating (median [IQR], 23.8% [20.4%-25.9%]), generalized anxiety disorder (median [IQR], 29.6% [14.0%-44.0%]), general functional impairments (median [IQR], 44.0% [23.4%-62.6%]), and fatigue or muscle weakness (median [IQR], 37.5% [25.4%-54.5%]), respectively. Other frequently reported symptoms included cardiac, dermatologic, digestive, and ear, nose, and throat disorders.

CONCLUSIONS AND RELEVANCE In this systematic review, more than half of COVID-19 survivors experienced PASC 6 months after recovery. The most common PASC involved functional mobility impairments, pulmonary abnormalities, and mental health disorders. These long-term PASC effects occur on a scale that could overwhelm existing health care capacity, particularly in low- and middle-income countries.

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Key Points

Question What are the short-term and long-term postacute sequelae of COVID-19 (PASC) infection?

Findings In this systematic review of 57 studies comprising more than 250 000 survivors of COVID-19, most sequelae included mental health, pulmonary, and neurologic disorders, which were prevalent longer than 6 months after SARS-CoV-2 exposure.

Meaning These findings suggest that long-term PASC must be factored into existing health care systems, especially in low- and middle-income countries.

+ Supplemental content

Author affiliations and article information are listed at the end of this article.

Introduction

The global COVID-19 pandemic that began in late 2019 has caused more than 187 million infections and 4 million deaths as of July 10, 2021.¹ Survivors experience long-lasting medical, psychological, and economic consequences, further increasing the disability-adjusted life years lost.² Despite current vaccination efforts,³ the health consequences of COVID-19 remain urgent, with long-term multi-organ system impacts that are yet to be elucidated. With a variety of clinical presentations and degrees of severity in patients,⁴ there is a dire need to better understand the lasting and emergent effects of COVID-19.

Frequently reported residual effects from SARS-CoV-2 virus include fatigue, dyspnea, chest pain, persistent loss of taste and/or smell, cognitive changes, arthralgias, and decreased quality of life. Many of these symptoms may result from widespread neuropathological events occurring in major white matter bundle tracts, cortical gray matter, and subcortical gray matter.⁵ In a study conducted in the United States by Chopra et al,⁶ 33% of patients had persistent symptoms at a 60-day follow-up after COVID-19 hospitalization. Similar trends have been observed in Europe.⁷ Furthermore, persistent symptoms (>6 weeks) have been reported in 19% of fully vaccinated individuals.⁸ However, as the pandemic emerged in 2019, most studies have been limited in the duration of observation, and there has yet to be a consolidation of these trends to portray an overarching evolution of these symptoms from short-term to long-term sequelae following COVID-19 infection.

To our knowledge, short-term and long-term sequelae of COVID-19 have not been systematically evaluated. In this paper, we synthesized the existing literature to estimate the overall and organ system-specific frequency of postacute sequelae of COVID-19 (PASC). We sorted studies into groups that focused on (1) postacute symptoms at 1-month after acute COVID-19 (short term), (2) persisting and new clinical manifestations between 2 and 5 months after infection (intermediate term), and (3) clinical manifestations that were present at least 6 months after COVID-19 (long term). These categorizations were based on literature reports proposing a framework that COVID-19 infection progresses from an acute infection lasting approximately 2 weeks into a postacute hyperinflammatory illness lasting approximately 4 weeks, until ultimately entering late sequelae.^{9,10} As we better understand the disease burden of PASC in COVID-19 survivors, we can develop precise treatment plans to improve clinical care in patients with COVID-19 who are at greatest risk of PASC and establish integrated, evidence-based clinical management for those affected.

Methods

Information Source and Search Strategy

The present study has been prospectively registered at PROSPERO ([CRD42021239708](https://doi.org/10.118568)) and followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) reporting guideline.¹¹ Databases were searched from December 2019 through March 2021, including PubMed (MEDLINE), Scopus, the World Health Organization Global Literature on Coronavirus Disease, and CoronaCentral. We manually searched the reference lists of included studies and other relevant documents to find additional studies. There were no limitations on country of publication or language. Non-English language articles were translated using the language translation services at the Penn State University Library. Predefined search terms included multiple combinations of the following: (COVID-19 OR coronavirus OR SARS-CoV-2 OR 2019-nCoV OR SARS nCoV2) AND (post-acute sequelae of SARS-CoV-2 OR long COVID-19 OR post-COVID-19 syndrome). Studies obtained from the search were transferred into EndNote version 9.3.2 (Clarivate), and duplicates were removed.

Eligibility and Inclusion Criteria

Studies were selected according to the following criteria: participants, adults and children with a previous COVID-19 infection; exposure, COVID-19; condition or outcome of interest, frequency of PASC; study design and context, randomized clinical trials, prospective and retrospective cohort studies, case series with at least 10 patients, and case-control studies. Inclusion criteria included the following: previous COVID-19 diagnosis and reported PASC frequencies.

Data Extraction

Two investigators (D.G. and A.S.) screened titles and abstracts of all identified articles for eligibility. Full-text articles were screened from eligible studies. Disagreements were resolved by discussion with a third investigator (P.S.). The following information was extracted by 2 investigators (D.G. and A.S.) independently: year of publication, country and time frame of the study, sample size of survivors of COVID-19, number of participants with PASC, mean (SD) or median (IQR) age, percentage male, percentage hospitalized, outcome of interest, time zero (ie, from diagnosis of COVID-19 or hospital discharge), and measurement methods for outcome of interest.

Study Quality Assessment

Two reviewers (D.G. and A.S.) independently assessed the quality of the included studies. The Newcastle-Ottawa Scale (NOS) was used for the quality assessment of the included studies.¹² Based on the NOS criteria, we assigned a maximum of 4 stars for selection, 2 stars for comparability, and 3 stars for exposure and outcome assessment. Studies with fewer than 5 stars were considered low quality; 5 to 7 stars, moderate quality; and more than 7 stars, high quality.

Definition of Short-term, Intermediate-term, and Long-term PASC

The primary outcome was the frequency of PASC, which was defined as the presence of at least 1 abnormality diagnosed by (1) laboratory investigation, (2) radiologic pathology, or (3) clinical signs and symptoms that was present at least 1 month after COVID-19 diagnosis or after discharge from the hospital. We defined short-term PASC as 1 month; intermediate-term, 2 to 5 months; and long-term, as 6 or more months after COVID-19 diagnosis or hospital discharge.

Statistical Analysis

A narrative approach was used to describe the number of studies, proportion male, proportion hospitalized, median or mean age (by study), whether the study was conducted in low- and middle-income countries (median gross national income, \leq \$12 535) or high-income countries (median gross national income, \geq \$12 536). We did not conduct a meta-analysis due to high heterogeneity in the outcome of interest. We summarized PASC rates descriptively, reporting medians and IQRs. PASC frequencies were summarized as short term, intermediate term, or long term and by organ system. R package ggplot2 was used to display the boxplots.¹³ All statistical analyses were performed with R software version 3.6.2 (R Project for Statistical Computing).

Results

Identified Studies

As shown in eFigure 1 in the [Supplement](#), we identified a total of 2100 studies. After excluding the duplicates and studies that did not meet inclusion criteria after screening the title, abstract, or main text, a total of 57 studies were included, with 250 351 survivors of COVID-19 who were assessed for PASC at 30 days after acute COVID-19 infection and beyond. The mean (SD) age of survivors was 54.4 (8.9) years, 140 196 (56%) were male, and 197 777 (79%) were hospitalized during acute COVID-19. High-income countries contributed 45 studies (79%). Study-specific details are provided in the [Table](#).^{6,7,14-68}

Table. Study Specific Details

Source	Country	Study type	Baseline	Timeframe, mo	Quality score	Outcome measurements	Male, %	Age, mean (SD), y	Hospitalized, %	PASC, No.	Sample size, No.
Carvalho-Schneider et al, ¹⁴ 2021	France	Prospective cohort	Diagnosis with confirmed laboratory result	1	5	mMRC dyspnea scale (dyspnea), self-reported symptoms scaled on 10-point analog scale (chest pain, anosmia, and ageusia)	43	49 (15)	29	103	150
Glick et al, ¹⁵ 2021	Germany	Prospective cohort	Diagnosis, with confirmed laboratory result	1	7	Serum laboratory tests, self-reported symptoms (fever, nausea, diarrhea, loss of smell or taste, fatigue, dyspnea, headache, cough, runny nose, sore throat, myalgia), enzyme-linked immunosorbent assay	38	Median, 40	NA	67	119
Pellaud et al, ¹⁶ 2020	Switzerland	Retrospective cohort	Diagnosis with confirmed laboratory result and hospital admission	1	5	Self-reported over telephone interview	61	Median (IQR), 70 (60-80)	100	73	196
Akter et al, ¹⁷ 2020	Bangladesh	Cross-sectional	Diagnosis with confirmed laboratory result	1	5	Medical records; self-report over telephone interview	76	NA	100	675	734
Panda et al, ¹⁸ 2020	India	Prospective cohort	Diagnosis with confirmed laboratory result and hospital admission	1	6	Self-reported over telephone interview	71	35 (13)	100	210	225
Huang et al, ¹⁹ 2020	China	Retrospective cohort	Hospital discharge	1	8	Medical records, lung radiography (chest abnormalities), 6MWT (functional status), spirometry (lung function)	46	46 (14)	100	31	57
Jacobs et al, ²⁰ 2020	US	Prospective cohort	Hospital discharge	1	5	Self-reported symptoms, PROMIS Scale version 1.2; Global Health and Item Bank version 1.0; Dyspnea Functional Limitations Short Form 10a	61.5	Median (IQR), 57 (48-68)	100	82	183
Poncet-Megmont et al, ²¹ 2020	France	Retrospective cohort	Diagnosis (laboratory result or positive CT)	1	5	Self-reported symptoms from telephone interview	13	49 (15)	45	20	139
Weerghandi et al, ²² 2021	United States	Prospective cohort	Hospital discharge	1	5	Self-report	57	57	100	113	152
Daher et al, ²³ 2020	Germany	Prospective cohort	Hospital discharge	1.5	6	Body plethysmography, serum laboratory tests, lung diffusion capacity, ABG, 6MWT, echocardiography, laboratory tests, quality of life (PHQ-9, GAD-7, SGRQ, and EQ-5D-5L)	67	64 (3)	100	15	33
de Graaf et al, ²⁴ 2021	Netherlands	Prospective cohort	Hospital discharge	1.5	7	Echocardiography, ECG monitoring, pulmonary function testing, GAD-7, PHQ-9, PCL-5, CFQ-25, IQ-CODE-N, PCFS	63	60.8 (13)	42	55	81
Tomasoni et al, ²⁵ 2021	Italy	Cross-sectional	Hospital discharge	1.5	5	Self-reported symptoms, HADS (mental status), MMSE (cognitive disorders)	73	Median (IQR), 55 (43-65)	100	55	105
Chiesa-Estomba et al, ²⁶ 2020	Spain	Prospective cohort	Diagnosis	1.5	7	Short Questionnaire of Olfactory Disorders-Negative Statements and self-reported ENT, olfactory, and gustatory dysfunction	36	41 (13)	100	384	751
Chopra et al, ⁶ 2021	US	Prospective cohort	Hospital discharge	2	6	Medical records	52	Median (IQR), 62 (50-72)	100	159	488
Mendez et al, ²⁷ 2021	Spain	Prospective cohort	Hospital discharge	2	7	Quality of Life (SF-12), verbal memory (SCIP), verbal fluency (ANT), working memory (WAIS-III), anxiety (GAD-7), depression (PHQ-2), PTSD (DTS)	58.7	Median (IQR), 57 (49-67)	100	79	179
Huang et al, ²⁸ 2021	United States	Retrospective cohort	Diagnosis (with confirmed laboratory result)	2	7	Medical records	28	NA	NA	380	1407
Smet et al, ²⁹ 2021	Belgium	Retrospective cohort	Diagnosis	2	6	Lung radiography (chest abnormalities), spirometry (lung function), laboratory data (lactate dehydrogenase, troponin, D-dimer)	62	55 (13)	NA	137	220

(continued)

Table. Study Specific Details (continued)

Source	Country	Study type	Baseline	Timeframe, mo	Quality score	Outcome measurements	Male, %	Age, mean (SD), y	Hospitalized, %	PASC, No.	Sample size, No.
Sonnwheber et al, ³⁰ 2020	Austria	Prospective cohort	Diagnosis	2	5	Self-reported symptoms, 6MWT (functional mobility), blood test	60	58 (14)	80	32	109
Vaira et al, ³¹ 2020	Italy	Prospective cohort	Diagnosis	2	5	Olfactory and gustatory psychophysical tests	49.3	51.2 (8.8)	23	8	138
Carvalho-Schneider et al, ¹⁴ 2021	France	Prospective cohort	Diagnosis with confirmed laboratory result	2	5	mMRC Dyspnea Scale (dyspnea), self-reported symptoms scaled on 10-point analog scale (chest pain, anosmia, and ageusia)	44	49 (15)	28	86	130
Puntmann et al, ³² 2020	Germany	Prospective cohort	Diagnosis with confirmed laboratory result	2	8	MRI (cardiac activity), laboratory data (cardiac activity), self-reported (other outcomes)	53	49 (14)	33	78	100
Carfi et al, ⁷ 2021	Italy	Prospective cohort	Hospital discharge	2	5	EQ-VAS (QOL); self-reported symptoms in patient survey	63	57 (15)	100	125	143
Rosales-Castillo et al, ³³ 2021	Spain	Retrospective cohort	Diagnosis with confirmed laboratory result	2	5	Self-reported symptoms	56	60 (15)	100	74	118
Halpin et al, ³⁴ 2021	UK	Prospective cohort	Hospital discharge	2	5	EQ-5D-5L (QOL); telephone interview screening tool (other outcomes)	54	Median (range), 71 (20-93)	100	64	100
Islam et al, ³⁵ 2021	UK	Prospective cohort	Diagnosis within 7 d of hospital admission	2	6	Self-reported symptoms via survey	52	Median (IQR), 66 (52-80)	100	114	403
D'Cruz et al, ³⁶ 2021	UK	Prospective cohort	Diagnosis at hospital admission	2	6	mMRC Dyspnea Scale (dyspnea); PHQ-9 (depression); TSQ (trauma); GAD-7 (anxiety); 6-CIT (cognitive impairment); CT scan (organ function); 4MGS (gait speed); 1-min sit-to-stand test (mobility)	62	59 (14)	100	106	119
Mandal et al, ³⁷ 2021	UK	Prospective cohort	Diagnosis upon hospital admission	2	6	Lung radiography (chest abnormalities); blood sample (laboratory assessments); PHQ-2 (depression); self-reported symptoms	62	60 (16)	100	276	384
Raman et al, ³⁸ 2021	UK	Prospective cohort	Hospital discharge	2.5	7	Radiographic imaging, spirometry, 6MWT (functional mobility), CPET (cardiopulmonary fitness), QOL, self-reported health assessment	58.6	55.4 (13.2)	100	54	58
Shah et al, ³⁹ 2021	Canada	Prospective cohort	Diagnosis with confirmed laboratory result	3	8	Pulmonary function test (lung function); 6MWT (mobility); CT scan (organ function); UCSD SOBQ (dyspnea)	68	Median (IQR), 67 (54-74)	100	53	60
Wong et al, ⁴⁰ 2020	Canada	Prospective cohort	Diagnosis with confirmed laboratory result	3	8	EQ-5D-5L (QOL); UCSD Frailty Index (frailty); UCSD SOBQ (shortness of breath); PSQI (sleep quality); PHQ-9 (depression), self-reported symptoms via survey	64	62 (16)	100	59	78
Taquet et al, ⁴¹ 2021	US	Retrospective cohort	Diagnosis	3	8	Medical records	44	46 (20)	20	78 005	236 379
Tabatabaei et al, ⁴² 2020	Iran	Retrospective cohort	Diagnosis with chest CT	3	6	Medical records, laboratory data (SpO ₂ , white blood cell, C-reactive protein, lactate dehydrogenase, leukocytosis), CT imaging	62	50 (13)	81	22	52
Glück et al, ¹⁵ 2021	Germany	Prospective cohort	Diagnosis	3	7	Serum laboratory tests, self-reported symptoms (fever, nausea, diarrhea, loss of smell or taste, fatigue, dyspnea, headache, cough, runny nose, sore throat, myalgia), enzyme-linked immunosorbent assay	38	Median, 40	NA	29	119
Townsend et al, ⁴³ 2020	Ireland	Prospective cohort	Acute illness recovery	3	7	CFQ-11 (fatigue), laboratory results (white blood cell, C-reactive protein, lactate dehydrogenase, interleukin 6, soluble interleukin-2 receptor)	46	50 (15)	55	67	128
Janiri et al, ⁴⁴ 2021	Italy	Prospective cohort	Acute illness recovery	3	7	Clinician-Administered PTSD Scale, self-reported COVID-19 characteristics	56	55 (15)	81	306	381

(continued)

Table. Study Specific Details (continued)

Source	Country	Study type	Baseline	Timeframe, mo	Quality score	Outcome measurements	Male, %	Age, mean (SD), y	Hospitalized, %	PASC, No.	Sample size, No.
van den Borst et al, ⁴⁵ 2020	Netherlands	Prospective cohort	Hospital discharge	3	6	Pulse-oximetry and spirometry (pulmonary function); mMRC Dyspnea Scale (dyspnea); CT scan and radiography (chest function); CFS (fatigue); HADS (anxiety and depression); TICS and CFQ (cognitive function); PCL-5 and IES-R (PTSD); SF-36 (QOL); blood sample (laboratory assessments)	60	59 (14)	100	89	124
Lerum et al, ⁴⁶ 2021	Norway	Prospective cohort	Hospital admission	3	5	Self-report: mMRC Dyspnea Scale, QOL (EQ-5D-5L), chest CT scan, pulmonary function tests (spirometry)	54	Median (IQR), 59 (49-72)	NA	37	103
Sibila et al, ⁴⁷ 2021	Spain	Prospective cohort	Hospital admission	3	4	Pulmonary function tests (spirometry and DLCO)	57	56 (16)	100	109	172
Arnold et al, ⁴⁸ 2021	UK	Prospective cohort	Hospital admission	3	6	Chest radiograph, pulmonary function tests (spirometry), exercise testing, serum laboratory tests, QOL (SF-36), WEMWBS	62	NA	100	81	110
Zhao et al, ⁴⁹ 2020	China	Retrospective cohort	Diagnosis or symptom onset	3	6	Medical records, chest CT, pulmonary function tests, serum laboratory tests	58	NA	NA	35	55
Weng et al, ⁵⁰ 2021	China	Prospective cohort	Hospital admission	3	3	Self-reported symptoms (fever, cough, dyspnea, gastrointestinal), medical records	56	NA	100	52	117
Xiong et al, ⁵¹ 2021	China	Prospective cohort	Hospital discharge	3	8	Medical records, self-report symptoms (general, respiratory, cardiovascular, psychological, and specifics)	46	Median (IQR), 52 (41-62)	100	267	538
Liang et al, ⁵² 2020	China	Prospective cohort	Hospital discharge	3	8	Self-reported symptoms, serum laboratory tests, pulmonary function tests, high-resolution CT imaging	28	41.3 (13.8)	100	45	76
Qu et al, ⁵³ 2021	China	Prospective cohort	Hospital discharge	3	5	Self-reported symptoms from phone interview, medical records for laboratory results, HRQoL (QOL)	50	Median (IQR), 47.5 (37-57)	100	311	540
Sonnweber et al, ⁵⁴ 2021	Austria	Prospective cohort	Hospital discharge	3	5	Self-reported, mMRC score (dyspnea), spirometry (lung function), lung and chest radiography, laboratory tests	55	57 (14)	75	59	145
Ugur et al, ⁵⁵ 2021	Turkey	Prospective cohort	Diagnosis, ie, laboratory result	3	5	Self-reported symptoms, B-SIT (smell abnormalities)	45	41 (14)	100	42	104
Peluso et al, ⁵⁶ 2021	US	Prospective cohort	Diagnosis or symptom onset	4	5	Somatic symptoms (PHQ), QOL (EuroQoL), mental health (GAD-7, PHQ-8, PCL-5)	56	Median (IQR), 48 (38-55)	37	65	119
Garrigues et al, ⁵⁷ 2020	UK	Prospective cohort	Hospital admission	4	6	mMRC Dyspnea Scale; QOL (EQ-5D-5L); health state (EQ-VAS)	75	63 (16)	100	66	120
Bellani et al, ⁵⁸ 2021	Italy	Prospective cohort	Hospital discharge	4	8	Pulmonary function tests, physical performance (SPPB), PTSD (IES-R)	60	Median (IQR), 61 (50-71)	31	238	767
Moreno-Perez et al, ⁵⁹ 2021	Spain	Prospective cohort	Diagnosis or symptom onset	4	8	QOL (EQ-VAS), chest radiographs, serum laboratory tests, pulmonary function tests	53	Median (IQR), 56 (53-72)	66	141	277
Guler et al, ⁶⁰ 2021	Switzerland	Prospective cohort	Acute illness recovery	4	6	Medical records, pulmonary function tests (spirometry, DLCO, respiratory strength), chest CT	59	NA	NA	37	113
Dennis et al, ⁶¹ 2021	UK	Prospective cohort	Diagnosis or symptom onset	5	8	Self-report, serum laboratory tests, MRI, QOL (EQ-5D-5L)	30	44 (11)	18	199	201
Logue et al, ⁶² 2021	US	Prospective cohort	Diagnosis or symptom onset	6	5	Self-reported symptoms	43	48 (15)	NA	55	177
Rauch et al, ⁶³ 2021	Germany	Prospective cohort	Diagnosis or symptom onset	6	5	Self-reported symptoms	32	NA	9	85	127
Trunfio et al, ⁶⁴ 2021	Italy	Retrospective cross-sectional	Diagnosis or symptom onset	6	8	Self-reported symptoms	56	Median (IQR), 56 (43-69)	64	41	200
Walle-Hansen et al, ⁶⁵ 2021	Norway	Prospective cohort	Hospital admission	6	5	QOL (EQ-5D-5L), VAS, cognitive capacity (MoCA), functional capacity (SPPB)	57	74	100	57	106

(continued)

Table. Study Specific Details (continued)

Source	Country	Study type	Baseline	Timeframe, mo	Quality score	Outcome measurements	Male, %	Age, mean (SD), y	Hospitalized, %	PASC, No.	Sample size, No.
Huang et al, ⁶⁶ 2021	China	Ambidirectional cohort	Diagnosis or symptom onset	6	8	Dyspnea (mMRC), QOL, anxiety, and depression (EQ-5D-5L and EQ-VAS), serum laboratory tests, CT scans, mobility (6MWT)	52	Median (range), 57 (0-65)	NA	1265	1655
Han et al, ⁶⁷ 2021	China	Prospective cohort	Diagnosis or symptom onset	6	8	Medical records, chest CT, pulmonary function tests (spirometry, DLCO)	70	54 (12)	62	40	114
Taboada et al, ⁶⁸ 2021	Spain	Prospective cohort	Hospital discharge	6	5	HRQoL (QOL), functional status, self-reported symptoms	59	65.5 (10.4)	100	61	91
Peluso et al, ⁵⁶ 2021	US	Prospective cohort	Diagnosis or symptom onset	8	5	Somatic symptoms (PHQ), QOL (EuroQoL), mental health (GAD-7, PHQ-8, PCL-5)	56	Median (IQR), 48 (38-55)	69	48	64
Glück et al, ¹⁵ 2021	Germany	Prospective cohort	After COVID-19 diagnosis	8	7	Serum laboratory work, self-reported symptoms (fever, nausea, diarrhea, loss of smell or taste, fatigue, dyspnea, headache, cough, runny nose, sore throat, myalgia), enzyme-linked immunosorbent assay	38	Median, 40	0	35	119

Abbreviations: 4MGS, 4-meter gait speed; 6-CIT, 6-item Cognitive Impairment Test; 6MWT, 6-minute walk test; ABG, arterial blood gas; ANT, Animal Naming Test; B-SIT, Brief Smell Identification Test; CFS, Clinical Frailty Scale; CFQ, Cognitive Failures Questionnaire-25; CPET, cardiopulmonary exercise test; CT, computed tomography; DLCO, diffusing capacity for carbon monoxide; DTS, Davidson Trauma Scale; ENT, ear, nose, and throat; ECG, electrocardiogram; EQ-5D-5L, EuroQoL 5-level 5-dimension; EQ-VAS, EuroQoL visual analog scale; GAD-7, General Anxiety Disorder-7; HADS, Hospital Anxiety and Depression Scale; HRQoL, health-related quality of life; IES-R, Impact of Events Scale; IQ-CODE-N, Informant Questionnaire on Cognitive Decline in the Elderly-Netherlands; mMRC, modified Medical Research Council; MMSE, Mini-Mental State Examination; MoCA, Montreal Cognitive Assessment; MRI, magnetic resonance imaging; NA, not available; PASC, post-acute sequelae of SARS-CoV-2 infection; PCL-5, PTSD Checklist of DSM-5; PCFS, Post-COVID-19 Functional Status; PHQ-2, Patient Health Questionnaire; PROMIS, Patient-Reported Outcomes Measurement Information System; PSQI, Pittsburgh Sleep Quality Index; PTSD, posttraumatic stress disorder; QOL, quality of life; SCIP, Screen for Cognitive Impairment in Psychiatry; SF, Short Form; SGRQ, St George Respiratory Questionnaire; SpO₂, peripheral capillary oxygen saturation; SOBQ, Shortness of Breath Questionnaire; SPPB, Short Physical Performance Battery; TICS, Telephone Interview for Cognitive Status; TSQ, Trauma Screening Questionnaire; UCSD, University of California, San Diego; WAIS-III, Wechsler Adult Intelligence Scale, third edition; WEMWBS, Warwick-Edinburgh Mental Well-being Scales.

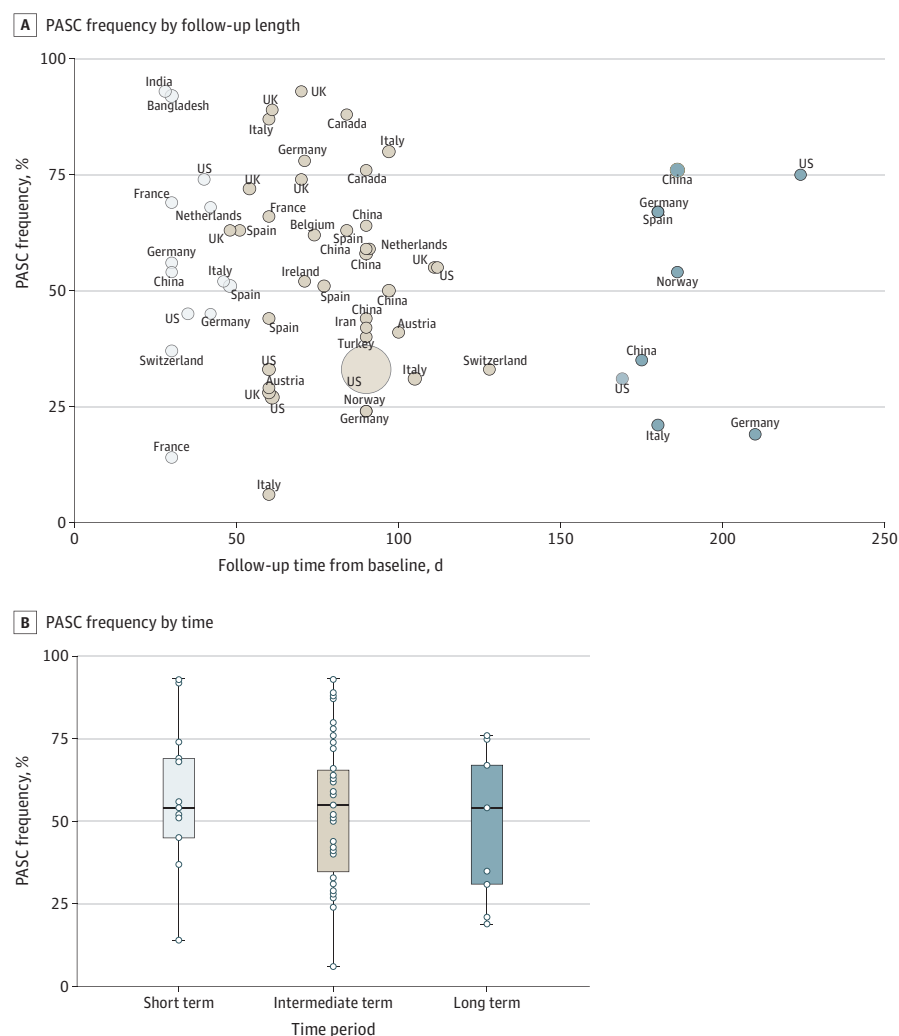
Frequency of PASC

Displayed in **Figure 1A** is the distribution of studies by country and follow-up time from baseline. PASC frequencies were stratified and reported by 1 month (short-term),¹⁴⁻²⁶ 2 to 5 months (intermediate-term),^{7,15,19,27-47,49-61,66,67} and 6 months (long-term)^{15,56,62-67} from COVID-19 diagnosis or hospital discharge (Figure 1B). The median (IQR) proportion of COVID-19 survivors experiencing at least 1 PASC at 1 month was 54.0% (45.0%-69.0%; 13 studies); at 2-5 months, 55.0% (34.8%-65.5%; 38 studies); and at 6 or more months, 54.0% (31.0%- 67.0%; 9 studies). When stratified by World Bank income groups, median (IQR) PASC frequency was 54.6% (33.0%-68.3%; 45 studies) in high-income countries and 56.0% (43.5%-67.0%; 12 studies) for low- and middle-income countries (eFigure 2A in the [Supplement](#)). PASC rates were similar in studies with higher ($\geq 60\%$) and lower ($<60\%$) percentages of hospitalized patients (eFigure 2B in the [Supplement](#)). In addition, when stratified by study methodological score, the proportion of PASC were similar (eFigure 2C in the [Supplement](#)).

Rates of Clinical Manifestations of PASC

A total of 38 clinical manifestations were assessed. We collapsed these clinical manifestations into categories of (1) organ systems, ie, neurologic, mental health, respiratory, cardiovascular, digestive, dermatologic, and ear, nose, and throat; (2) constitutional symptoms; and (3) functional mobility.

Figure 1. Studies Included Studying Postacute Sequelae of COVID-19 (PASC)

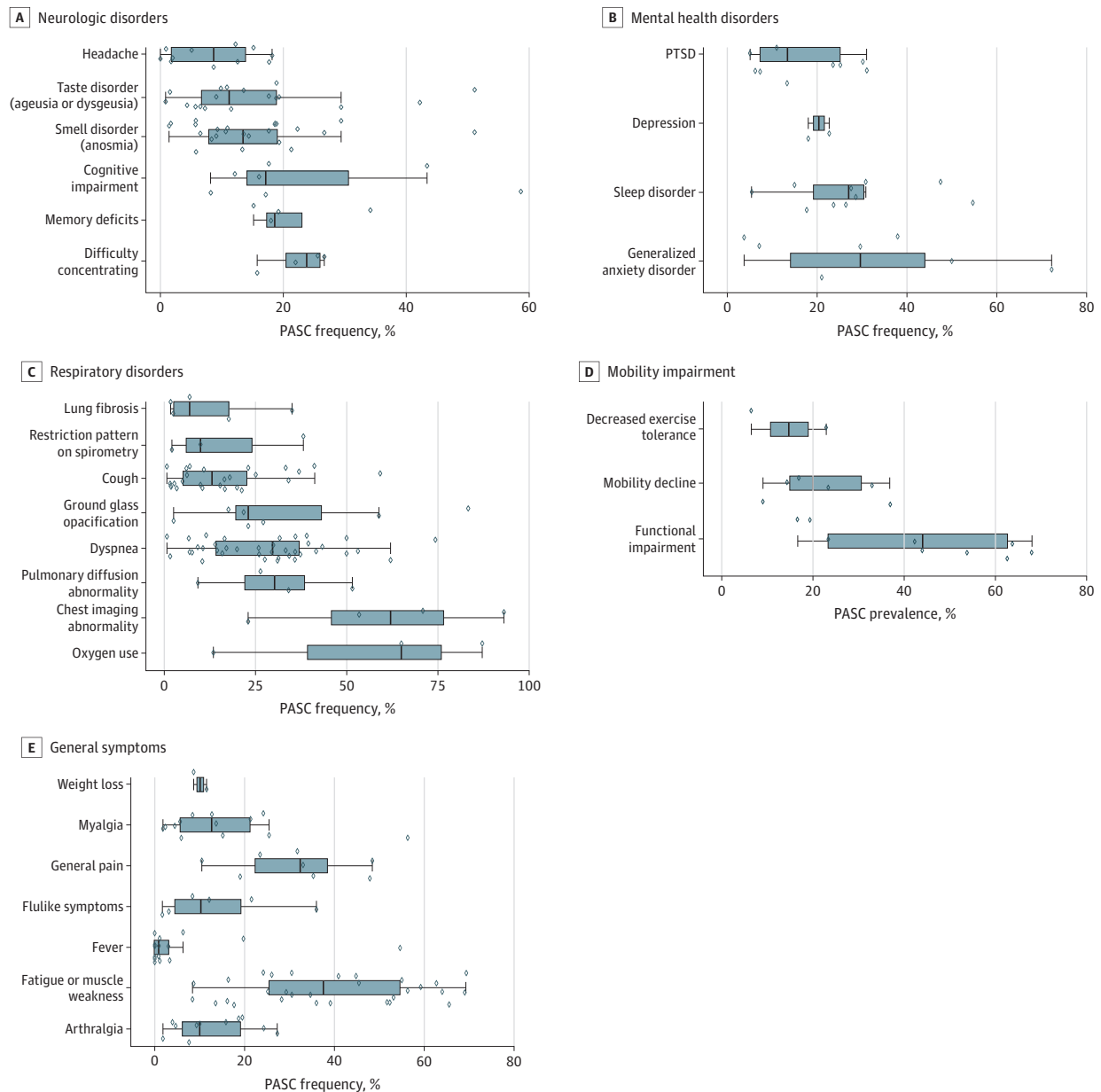


A, Scatterplot representing each study's PASC frequency (%) plotted according to length of follow-up from baseline (in days), represented by a circle proportional to the study's sample size and annotated according to country. B, Box plot representing the frequency of PASC reported by follow-up period. The horizontal bar in each box plot is the median value for the outcome of interest. The edges of the box represent the first and third quartiles. The width of the box is the IQR. The whiskers extend to the smallest and largest observations within 1.5 times the IQR of the quartiles. The circles represent point estimates for each study included in the analysis. Circles extending beyond the whiskers are outliers.

Neurologic Symptoms

Various neurologic symptoms were reported (**Figure 2A**). These included headaches, memory deficits, difficulty concentrating, and cognitive impairment. Even though anosmia (loss of smell) and ageusia or dysgeusia (loss or distortion of taste) are often reported as part of ear nose and throat system, we chose to include them in the neurologic symptoms because they are a consequence of the effect of the virus on the cranial nerve 1 (olfactory nerve) for smell and cranial nerves VII (facial), IX (glossopharyngeal nerve), and X (vagal nerve) for taste. The most common neurocognitive symptoms were difficulty concentrating (4 studies; median [IQR], 23.8% [20.4%-25.9%]), memory deficits (4 studies; median [IQR], 18.6% [17.3%-22.9%]), cognitive impairment (7 studies; median

Figure 2. Neurologic, Mental Health, Respiratory, Mobility, and General Postacute Sequelae of COVID-19 (PASC) Symptoms



The vertical bar in each box plot is the median value for the outcome of interest. The edges of the box represent the first and third quartiles. The width of the box is the IQR. The whiskers extend to the smallest and largest observations within 1.5 times the IQR of

the quartiles. The diamonds represent point estimates for each study included in the analysis. Diamonds extending beyond the whiskers are outliers. PTSD indicates posttraumatic stress disorder.

[IQR], 17.1% [14.1%-30.5%]). Dysgeusia and anosmia were reported in 11% (18 studies; median [IQR], 11.2% [6.7%-18.9%]) and 13% (24 studies; median [IQR], 13.4% [7.9%-19.0%]) of the survivors, respectively. Overall, headache symptoms were reported in 8% (11 studies; median [IQR], 8.7% [1.9%-13.9%]) of COVID-19 survivors. However, disparities existed in headache symptoms by study, ranging from 0% in Bellan and colleagues⁵⁸ to 18% in Zhao et al.⁴⁹

Mental Health Disorders

A variety of standardized instruments were used to assess mental health. These included the Patient Health Questionnaire (PHQ) 2 to screen for depression, the PHQ 9 to evaluate major depressive disorder, the General Anxiety Disorder 7 to assess generalized anxiety disorder, the Hospital Anxiety and Depression Scale to measure symptoms of anxiety and depression, and the PTSD Checklist of *DSM-5* and the Impact of Events Scale to assess the presence and severity of posttraumatic stress disorder symptoms. The Pittsburgh Sleep Quality Index questionnaire was used to assess sleep quality and disturbances (Table). Depression or anxiety were reported in 9 studies, and the rates were consistent (Figure 2B). Approximately 1 in 3 COVID-19 survivors was diagnosed with generalized anxiety disorders (7 studies; median [IQR], 29.6% [14.0%-44.0%]), 1 in 4 with sleep disorders (10 studies; median [IQR], 27.0% [19.2%-30.3%]), 1 in 5 with depression (2 studies; median [IQR], 20.4% [19.2%-21.5%]), and 1 in 8 with posttraumatic stress disorder (9 studies; median [IQR], 13.3% [7.3%-25.1%]).

Pulmonary Abnormalities

Pulmonary manifestations of PASC were assessed with pulmonary function tests (such as spirometry, diffusing capacity for carbon monoxide, and respiratory strength) and imaging modalities including chest radiograph, computed tomography scans, and magnetic resonance imaging. Dyspnea was mainly assessed with the Modified Medical Research Council Dyspnea Scale. Dyspnea was reported in 38 studies (median [IQR], 29.7% [14.2%-37.0%]), and cough was reported in 26 studies (median [IQR], 13.1% [5.3%-22.6%]). Increased oxygen requirement was reported in nearly two-thirds of COVID-19 survivors (3 studies; median [IQR], 65.0% [39.3%-76.1%]). Other frequently reported sequelae included pulmonary diffusion abnormalities (4 studies; median [IQR], 30.3% [22.1%-38.5%]), ground glass opacification (7 studies; median [IQR], 23.1% [19.7%-43.0%]), restrictive patterns on spirometry (3 studies; median [IQR], 10.0% [6.1%-24.1%]), and lung fibrosis (5 studies; median [IQR], 7.0% [2.5%-17.7%]) (Figure 2C). Overall, chest imaging abnormalities were present in a median (IQR) of 62.2% (45.8%-76.5%) of survivors (4 studies).

Functional Mobility Impairment

Three functional mobility impairments were assessed in this systematic review. They were impairment in general functioning (9 studies; median [IQR], 44.0% [23.4%-62.6%]), mobility decline (6 studies; median [IQR], 20.2% [14.9%-30.6%]), and reduced exercise tolerance (2 studies; median [IQR], 14.7% [10.6%-18.8%]) (Figure 2D).

General and Constitutional Symptoms

Due to their subjective nature and self-reportage of symptoms (Table), general well-being and constitutional symptoms varied widely between studies. In this category, we noted 7 persisting symptoms among survivors of COVID-19 (Figure 2E). These included fatigue or muscle weakness, joint pain, muscle pain, flu-like symptoms, fever, general pain, and weight loss. Most commonly reported symptoms were joint pain (11 studies; median [IQR], 10.0% [6.1%-19.0%]), fatigue or muscle weakness (30 studies; median [IQR], 37.5% [25.4%-54.5%]), and flu-like symptoms (6 studies; median [IQR], 10.3% [4.5%-19.2%]). General pain (8 studies; median [IQR], 32.4% [22.3%-38.4%]), persistent fever (16 studies; median [IQR], 0.9% [0%-3.1%]), and muscle pain (13 studies; median [IQR], 12.7% [5.6%-21.3%]) were also frequently reported among survivors. Fever rates decreased as a function of time: by 60 days of follow-up, persistent fever rates reduced from 3% to 0% in studies

by Carvalho-Schneider and colleagues.¹⁴ Except for Glück et al¹⁵ at a 1-month follow-up, the reported fever rates were less than 20%. The high fever rates reported in Glück et al¹⁵ can potentially be explained by unusually high anti-SARS-CoV-2 immunoglobulin G levels in their patient population of frontline health care workers, which was significantly associated with the severity of disease as reported by the authors. Fever rates for the subsequent follow-ups at 3, 5, and more than 6 months after diagnosis were all at 0% in the Glück study.¹⁵ Carvalho-Schneider et al¹⁴ reported a slight increase in unintentional weight loss (defined as a loss of more than or equal to 5% of body weight at baseline) from 9% to 12% at day 30 to day 60 of follow-up, respectively.

Cardiovascular Disorders

Chest pain and palpitations were common cardiovascular manifestations in survivors of COVID-19 (Figure 3A). The median (IQR) frequency of chest pain and palpitation were 13.3% (8.8%-17.8%; 14 studies) and 9.3% (6.0%-10.8%; 5 studies), respectively. Other reported diagnoses, such as myocardial infarction and heart failure, were not as frequently reported in the literature.

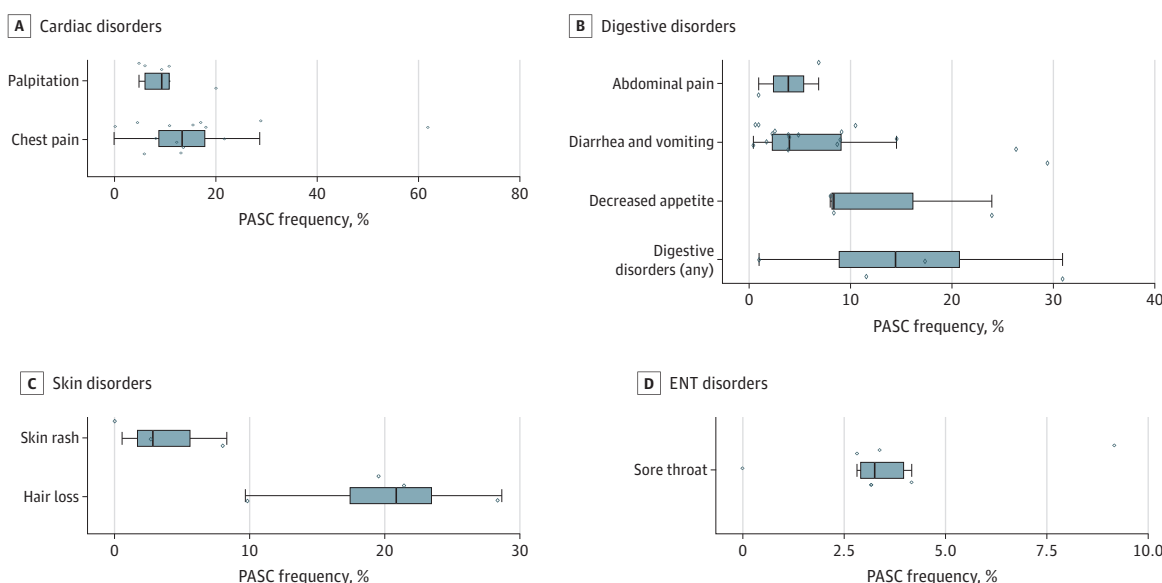
Gastrointestinal, Dermatologic, and Ear, Nose, and Throat Disorders

The overall rate of gastrointestinal disorders was 6% and included abdominal pain, decreased appetite, diarrhea, and vomiting (Figure 3B). Hair loss (4 studies; median [IQR], 20.8% [17.4%-23.4%]) and skin rash (3 studies; median [IQR], 2.8% [1.7%-5.6%]) constituted dermatologic disorders (Figure 3C). Finally, sore throat was a concern among 3% of COVID-19 survivors (6 studies; median [IQR], 3.3%, [2.9%-4.0%]) (Figure 3D).

Discussion

In this systematic review, we evaluated the temporal progression of clinical abnormalities experienced by patients who recovered from an infection with SARS-CoV-2, starting with a mean of 30 days post-acute illness and beyond. The results suggest that rates of PASC are indeed common; 5 of 10 survivors of COVID-19 developed a broad array of pulmonary and extrapulmonary clinical

Figure 3. Cardiac, Digestive, Skin, and Ear, Nose, and Throat (ENT) Postacute Sequelae of COVID-19 (PASC) Symptoms



The vertical bar in each box plot is the median value for the outcome of interest. The edges of the box represent the first and third quartiles. The width of the box is the IQR. The whiskers extend to the smallest and largest observations within 1.5 times the IQR of

the quartiles. The diamonds represent point estimates for each study included in the analysis. Diamonds extending beyond the whiskers are outliers.

manifestations, including nervous system and neurocognitive disorders, mental health disorders, cardiovascular disorders, gastrointestinal disorders, skin disorders, and signs and symptoms related to poor general well-being, including malaise, fatigue, musculoskeletal pain, and reduced quality of life. Short- and long-term rates of PASC were similar, highlighting the potential for pathological sequelae long after exposure to the SARS-CoV-2 virus.

The mechanisms underpinning the postacute and chronic manifestations of COVID-19 are not entirely understood. Nevertheless, these mechanisms can be grouped into the direct effect of the viral infection and the indirect effect on mental health due to posttraumatic stress, social isolation, and economic factors, such as loss of employment.^{69,70} Direct viral effects can be explained by several hypotheses, including persistent viremia due to immune fatigue and paresis,⁷¹ relapse or reinfection,⁷² hyperinflammatory immune response, cytokine- and hypoxia-induced injury,⁷³ and autoimmunity⁷⁴ as well as neurotropism using a transsynaptic spread mechanism,⁵ resulting in hypoxic- or hemorrhagic-driven neuronal apoptosis.⁷⁵ Herein, widespread acute injury to cortical/subcortical and white matter fiber bundles may affect brain function and impede distal brain connectivity, respectively, manifesting in common symptoms, such as those identified in this review. These symptoms may include headache (ie, encephalopathy), cognitive deficits (ie, widespread neuropathological events), and smell and taste disorders (ie, acute injury to olfactory bulb).

At the forefront of clinical care for acute COVID-19 are multiple guidelines, recommendations, and best practices that have been disseminated and prioritized for prevention and management. However, no clear guidelines are currently available for postinfectious care or recovery, and there is a notable dearth of information on and strategies about how to assess and manage patients following their acute COVID-19 episode. This is in part due to a high degree of between-study heterogeneity in defining PASC. Indeed, this heterogeneity was evident the present study. We noted varying definitions of time zero, which included symptom onset, COVID-19 diagnosis, hospital admission, or hospital discharge. Furthermore, variations in the specific outcomes of interest and the outcome measurement tools existed, hindering us from pooling the data in a formal meta-analytic model. SARS-CoV-2 variant types and breakthrough infectivity rates among fully vaccinated individuals will likely modify the manifestations and incidence of PASC further.⁸

Our results indicate that clinical management of PASC will require a whole-patient perspective, including management tools like virtual rehabilitation platforms and chronic care for post-acute COVID-19 symptoms in conjunction with the management of preexisting^{76,77} or new comorbidities.⁷⁸ One-stop multidisciplinary clinics are therefore recommended to avoid multiple referrals to different specialists and encourage comprehensive care. Based on our work and the recent systematic reviews by Nasserie and colleagues,⁷⁹ these specialists should include respiratory physicians, cardiologists, neurologists, general physicians (from primary care or rehabilitation medicine), neuropsychologists or neuropsychiatrists, physiotherapists, occupational therapists, speech and language therapists, and dieticians.⁸⁰

The clinical and public health implications of our findings are 2-fold. In addition to the life lost from acute COVID-19 illness, many individuals experience disability due to PASC, greatly exacerbating the disease burden.⁸¹ Such a burden is more than enough to overwhelm existing health care system capacities, particularly in resource-constrained settings. Second, predictive models of postacute and chronic COVID-19 sequelae using clinical and laboratory data obtained during the acute phase of COVID-19 are critically needed to inform effective strategies to mitigate or prevent PASC.

Limitations

This study has limitations. First, there is no consensus on the definition of postacute COVID-19. PASC currently has many definitions, including (1) the presence of symptoms beyond 3 weeks from the initial onset of symptoms⁷⁸; (2) symptoms that develop during or following an infection consistent with COVID-19, continue for more than 4 weeks, and are not explained by an alternative diagnosis⁸⁰; and (3) signs and symptoms at 12 weeks after infection and beyond. This led to considerable heterogeneity in PASC definitions among the articles synthesized in this systematic review.

Therefore, it was difficult to precisely compare the percentages of patients with abnormalities on follow-up visits between studies and to obtain a standardized understanding of patients' long-term symptoms from COVID-19. Second, we were not able to stratify the risk of PASC by severity of initial illness (for example, community-based vs hospitalized vs required care in an intensive care unit vs required invasive life-sustaining measures) or by preexisting comorbidities, patient age, or other factors that may affect an individual patient's risk of PASC. Third, the lack of standard reporting also created differences in how PASC sequelae were analyzed. Fourth, many studies investigated the prevalence of specific outcomes instead of reporting all symptoms present at various points post-COVID-19 infection. This limits the ability for a comprehensive, generalizable analysis of the long-term effects of COVID-19. Fifth, many studies included in this analysis were obtained from manual searching through references. This might suggest a need for improved database search terms for subsequent studies.

Conclusions

These findings suggest that PASC is a multisystem disease, with high prevalence in both short-term and long-term periods. These long-term PASC effects occurred on a scale sufficient to overwhelm existing health care capacity, particularly in resource-constrained settings. Moving forward, clinicians may consider having a low threshold for PASC and must work toward a holistic clinical framework to deal with direct and indirect effects of SARS-CoV-2 sequelae.

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Corresponding Author: Vernon M. Chinchilli, PhD, Department of Public Health Sciences, Penn State College of Medicine and Milton S. Hershey Medical Center, 90 Hope Dr, Ste 2400, Hershey, PA 17033-0855 (vchinch@psu.edu).

Author Affiliations: Department of Surgery, Penn State College of Medicine and Milton S. Hershey Medical Center, Hershey, Pennsylvania (Groff, Sun, A. E. Ssentongo); Department of Public Health Sciences, Penn State College of Medicine and Milton S. Hershey Medical Center, Hershey, Pennsylvania (A. E. Ssentongo, Ba, Lekoubou, Oh, P. Ssentongo, Chinchilli); Cognitive Neuroscience Unit, School of Psychology, Deakin University, Melbourne, Victoria, Australia (Parsons); Mary MacKillop Institute for Health Research, Department of Health Sciences, Australian Catholic University, Melbourne, Victoria, Australia (Poudel); Department of Neurology, Penn State College of Medicine and Milton S. Hershey Medical Center, Hershey, Pennsylvania (Lekoubou); Division of Infectious Disease, Department of Pediatrics, Penn State College of Medicine and Milton S. Hershey Medical Center, Hershey, Pennsylvania (Ericson); Center for Neural Engineering, Department of Engineering, Science and Mechanics, The Pennsylvania State University, State College (P. Ssentongo).

Author Contributions: Dr P. Ssentongo had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Mss Groff and Sun and Dr A. Ssentongo contributed equally to this study and are joint first authors. Drs P. Ssentongo and Chinchilli contributed equally to this study and are joint senior authors.

Concept and design: Groff, Sun, A. Ssentongo, Ba, Lekoubou, P. Ssentongo, Chinchilli.

Acquisition, analysis, or interpretation of data: Groff, Sun, A. Ssentongo, Ba, Parsons, Poudel, Oh, Ericson, P. Ssentongo, Chinchilli.

Drafting of the manuscript: Groff, Sun, A. Ssentongo, Parsons, Oh, P. Ssentongo, Chinchilli.

Critical revision of the manuscript for important intellectual content: Groff, Sun, A. Ssentongo, Ba, Poudel, Lekoubou, Oh, Ericson, P. Ssentongo, Chinchilli.

Statistical analysis: Groff, Sun, A. Ssentongo, Ba, P. Ssentongo, Chinchilli.

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Additional Information: R code and data to reproduce the results in the present manuscript are archived at GitHub (<https://github.com/ssentongojeddy/Post-Acute-Sequelae-of-SARS-CoV-2-Infection>).

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SUPPLEMENT.

eFigure 1. Flow Diagram for Systematic Review of PASC

eFigure 2. PASC Frequencies Stratified by National Income Level, Proportion Hospitalized, and Study Methodological Quality



Cochrane Database of Systematic Reviews

Signs and symptoms to determine if a patient presenting in primary care or hospital outpatient settings has COVID-19 (Review)

Struyf T, Deeks JJ, Dinnes J, Takwoingi Y, Davenport C, Leeftang MMG, Spijker R, Hooft L, Emperador D, Domen J, Horn SRA, Van den Bruel A, Cochrane COVID-19 Diagnostic Test Accuracy Group

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[Diagnostic Test Accuracy Review]

Signs and symptoms to determine if a patient presenting in primary care or hospital outpatient settings has COVID-19

Thomas Struyf¹, Jonathan J Deeks^{2,3}, Jacqueline Dinnes^{3,4}, Yemisi Takwoingi^{2,3}, Clare Davenport^{2,3}, Mariska MG Leeftang^{5,6}, René Spijker^{7,8}, Lotty Hooft⁹, Devy Emperador¹⁰, Julie Domen¹, Sebastiaan RA Horn¹¹, Ann Van den Bruel¹, Cochrane COVID-19 Diagnostic Test Accuracy Group³

¹Department of Public Health and Primary Care, KU Leuven, Leuven, Belgium. ²Test Evaluation Research Group, Institute of Applied Health Research, University of Birmingham, Birmingham, UK. ³NIHR Birmingham Biomedical Research Centre, University Hospitals Birmingham NHS Foundation Trust and University of Birmingham, Birmingham, UK. ⁴Test Evaluation Research Group, Institute of Applied Health Research, University of Birmingham, Birmingham, UK. ⁵Epidemiology and Data Science, Amsterdam University Medical Centers, University of Amsterdam, Amsterdam, Netherlands. ⁶Biomarker and Test Evaluation Programme (BiTE), Amsterdam UMC, University of Amsterdam, Amsterdam, Netherlands. ⁷Medical Library, Amsterdam UMC, University of Amsterdam, Amsterdam Public Health, Amsterdam, Netherlands. ⁸Cochrane Netherlands, Julius Center for Health Sciences and Primary Care, University Medical Center Utrecht, Utrecht University, Utrecht, Netherlands. ⁹Cochrane Netherlands, Julius Center for Health Sciences and Primary Care, University Medical Center Utrecht, Utrecht University, Utrecht, Netherlands. ¹⁰FIND, Geneva, Switzerland. ¹¹De Wijkpraktijk, Antwerp, Belgium

Contact address: Ann Van den Bruel, ann.vandenbruel@kuleuven.be.

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ABSTRACT

Background

The clinical implications of SARS-CoV-2 infection are highly variable. Some people with SARS-CoV-2 infection remain asymptomatic, whilst the infection can cause mild to moderate COVID-19 and COVID-19 pneumonia in others. This can lead to some people requiring intensive care support and, in some cases, to death, especially in older adults. Symptoms such as fever, cough, or loss of smell or taste, and signs such as oxygen saturation are the first and most readily available diagnostic information. Such information could be used to either rule out COVID-19, or select patients for further testing. This is an update of this review, the first version of which published in July 2020.

Objectives

To assess the diagnostic accuracy of signs and symptoms to determine if a person presenting in primary care or to hospital outpatient settings, such as the emergency department or dedicated COVID-19 clinics, has COVID-19.

Search methods

For this review iteration we undertook electronic searches up to 15 July 2020 in the Cochrane COVID-19 Study Register and the University of Bern living search database. In addition, we checked repositories of COVID-19 publications. We did not apply any language restrictions.

Selection criteria

Studies were eligible if they included patients with clinically suspected COVID-19, or if they recruited known cases with COVID-19 and controls without COVID-19. Studies were eligible when they recruited patients presenting to primary care or hospital outpatient settings. Studies in hospitalised patients were only included if symptoms and signs were recorded on admission or at presentation. Studies including patients who contracted SARS-CoV-2 infection while admitted to hospital were not eligible. The minimum eligible sample size of studies was 10 participants. All signs and symptoms were eligible for this review, including individual signs and symptoms or combinations. We accepted a range of reference standards.

Data collection and analysis

Pairs of review authors independently selected all studies, at both title and abstract stage and full-text stage. They resolved any disagreements by discussion with a third review author. Two review authors independently extracted data and resolved disagreements by discussion with a third review author. Two review authors independently assessed risk of bias using the Quality Assessment tool for Diagnostic Accuracy Studies (QUADAS-2) checklist. We presented sensitivity and specificity in paired forest plots, in receiver operating characteristic space and in dumbbell plots. We estimated summary parameters using a bivariate random-effects meta-analysis whenever five or more primary studies were available, and whenever heterogeneity across studies was deemed acceptable.

Main results

We identified 44 studies including 26,884 participants in total. Prevalence of COVID-19 varied from 3% to 71% with a median of 21%. There were three studies from primary care settings (1824 participants), nine studies from outpatient testing centres (10,717 participants), 12 studies performed in hospital outpatient wards (5061 participants), seven studies in hospitalised patients (1048 participants), 10 studies in the emergency department (3173 participants), and three studies in which the setting was not specified (5061 participants). The studies did not clearly distinguish mild from severe COVID-19, so we present the results for all disease severities together.

Fifteen studies had a high risk of bias for selection of participants because inclusion in the studies depended on the applicable testing and referral protocols, which included many of the signs and symptoms under study in this review. This may have especially influenced the sensitivity of those features used in referral protocols, such as fever and cough. Five studies only included participants with pneumonia on imaging, suggesting that this is a highly selected population. In an additional 12 studies, we were unable to assess the risk for selection bias. This makes it very difficult to judge the validity of the diagnostic accuracy of the signs and symptoms from these included studies.

The applicability of the results of this review update improved in comparison with the original review. A greater proportion of studies included participants who presented to outpatient settings, which is where the majority of clinical assessments for COVID-19 take place. However, still none of the studies presented any data on children separately, and only one focused specifically on older adults.

We found data on 84 signs and symptoms. Results were highly variable across studies. Most had very low sensitivity and high specificity. Only cough (25 studies) and fever (7 studies) had a pooled sensitivity of at least 50% but specificities were moderate to low. Cough had a sensitivity of 67.4% (95% confidence interval (CI) 59.8% to 74.1%) and specificity of 35.0% (95% CI 28.7% to 41.9%). Fever had a sensitivity of 53.8% (95% CI 35.0% to 71.7%) and a specificity of 67.4% (95% CI 53.3% to 78.9%). The pooled positive likelihood ratio of cough was only 1.04 (95% CI 0.97 to 1.11) and that of fever 1.65 (95% CI 1.41 to 1.93).

Anosmia alone (11 studies), ageusia alone (6 studies), and anosmia or ageusia (6 studies) had sensitivities below 50% but specificities over 90%. Anosmia had a pooled sensitivity of 28.0% (95% CI 17.7% to 41.3%) and a specificity of 93.4% (95% CI 88.3% to 96.4%). Ageusia had a pooled sensitivity of 24.8% (95% CI 12.4% to 43.5%) and a specificity of 91.4% (95% CI 81.3% to 96.3%). Anosmia or ageusia had a pooled sensitivity of 41.0% (95% CI 27.0% to 56.6%) and a specificity of 90.5% (95% CI 81.2% to 95.4%). The pooled positive likelihood ratios of anosmia alone and anosmia or ageusia were 4.25 (95% CI 3.17 to 5.71) and 4.31 (95% CI 3.00 to 6.18) respectively, which is just below our arbitrary definition of a 'red flag', that is, a positive likelihood ratio of at least 5. The pooled positive likelihood ratio of ageusia alone was only 2.88 (95% CI 2.02 to 4.09).

Only two studies assessed combinations of different signs and symptoms, mostly combining fever and cough with other symptoms. These combinations had a specificity above 80%, but at the cost of very low sensitivity (< 30%).

Authors' conclusions

The majority of individual signs and symptoms included in this review appear to have very poor diagnostic accuracy, although this should be interpreted in the context of selection bias and heterogeneity between studies. Based on currently available data, neither absence nor presence of signs or symptoms are accurate enough to rule in or rule out COVID-19. The presence of anosmia or ageusia may be useful as a red flag for COVID-19. The presence of fever or cough, given their high sensitivities, may also be useful to identify people for further testing.

Prospective studies in an unselected population presenting to primary care or hospital outpatient settings, examining combinations of signs and symptoms to evaluate the syndromic presentation of COVID-19, are still urgently needed. Results from such studies could inform subsequent management decisions.

PLAIN LANGUAGE SUMMARY

Can symptoms and medical examination accurately diagnose COVID-19?

COVID-19 affects many organs of the body, so people with COVID-19 may have a wide spectrum of symptoms. Symptoms and signs of the illness may be important to help them and the healthcare staff they come into contact with know whether they have the disease.

Symptoms: people with mild COVID-19 might experience cough, sore throat, high temperature, diarrhoea, headache, muscle or joint pain, fatigue, and loss or disturbance of sense of smell and taste.

Signs are obtained by clinical examination. Signs of COVID-19 examined in this review include lung sounds, blood pressure, blood oxygen level and heart rate.

Often, people with mild symptoms consult their doctor (general practitioner). People with more severe symptoms might visit a hospital outpatient or emergency department. Depending on the results of a clinical examination, patients may be sent home to isolate, may receive further tests or be hospitalised.

Why is accurate diagnosis important?

Accurate diagnosis ensures that people take measures to avoid transmitting the disease and receive appropriate care. This is important for individuals as it reduces harm and it saves time and resources.

What did we want to find out?

We wanted to know how accurate diagnosis of COVID-19 is in a primary care or hospital setting, based on symptoms and signs from medical examination.

What did we do?

We searched for studies that assessed the accuracy of symptoms and signs to diagnose COVID-19. Studies had to be conducted in primary care or hospital outpatient settings only. Studies of people in hospital were only included if symptoms and signs were recorded when they were admitted to the hospital.

The included studies

We found 44 relevant studies with 26,884 participants. The studies assessed 84 separate signs and symptoms, and some assessed combinations of signs and symptoms. Three studies were conducted in primary care (1824 participants), nine in specialist COVID-19 testing clinics (10,717 participants), 12 studies in hospital outpatient settings (5061 participants), seven studies in hospitalised patients (1048 participants), 10 studies in the emergency department (3173 participants), and in three studies the setting was not specified (5061 participants). No studies focused specifically on children, and only one focused on older adults.

Main results

The studies did not clearly distinguish between mild and severe COVID-19, so we present the results for mild, moderate and severe disease together.

The symptoms most frequently studied were cough and fever. In our studies, on average 21% of the participants had COVID-19, which means in a group of 1000 people, around 210 would have COVID-19.

According to the studies in our review, in the same 1000 people, around 655 people would have a cough. Of these, 142 would actually have COVID-19. Of the 345 who do not have a cough, 68 would have COVID-19.

In the same 1000 people, around 371 people would have a fever. Of these, 113 would actually have COVID-19. Of the 629 patients without fever, 97 would have COVID-19.

The loss of sense of smell or taste also substantially increase the likelihood of COVID-19 when they are present. For example, in a population where 2% of the people have COVID-19, having either loss of smell or loss of taste would increase a persons' likelihood of having COVID-19 to 8%.

How reliable are the results?

The accuracy of individual symptoms and signs varied widely across studies. Moreover, the studies selected participants in a way that meant the accuracy of tests based on symptoms and signs may be uncertain.

Conclusions

Most studies were conducted in hospital settings, so the results may not be entirely representative of primary care settings. The results do not apply to children or older adults specifically, and do not clearly differentiate between disease severities.

The results suggest that a single symptom or sign included in this review cannot accurately diagnose COVID-19. However, the presence of loss of taste or smell may serve as a red flag for the presence of the disease. The presence of high temperature or cough may also be useful to identify people who might have COVID-19. These symptoms may be useful to prompt further testing when they are present.

Further research is needed to investigate combinations of symptoms and signs; and testing unselected populations, in primary care settings and in children and older adults.

How up to date is this review?

For this update of the review, the authors searched for studies published from January to July 2020.

SUMMARY OF FINDINGS

Summary of findings 1. Signs and symptoms to determine if a patient presenting in primary care or hospital outpatient setting has COVID-19

Sign or symptom	Study design	Setting	Number of studies/number of participants	Sensitivity (ranges)	Specificity (ranges)	Strength of evidence
						Number of studies with high risk of bias per QUADAS-2 domain: participant selection/index test/reference standard/flow and timing
Patient or population: people with COVID-19 symptoms						
Setting: primary care or hospital outpatient departments						
Index test(s): signs and symptoms of COVID-19						
Target condition: SARS-CoV-2 infection (symptomatic of any severity); mild or moderate COVID-19; severe or critical COVID-19						
Reference standard: RT-PCR						
Only signs and symptoms for which at least one cross-sectional study observed a sensitivity of at least 50% are included. Pooled sensitivity and specificity were estimated for cross-sectional studies only.						
Cough	Cross-sectional	Primary care	2/968	52% to 70%	30% to 47%	1/1/1/1
		Outpatient clinics/ED	19/13,061	16% to 89%	11% to 79%	5/19/1/2
	Hospital inpatients	Hospital inpatients	2/158	52% to 55%	35% to 42%	1/2/0/1
		Unclear	2/1272	78% to 85%	13% to 37%	0/2/0/0
	All settings		25/15,459	67% (pooled summary estimate)	35% (pooled summary estimate)	
Case-control		Primary care	-	-	-	

Signs and symptoms to determine if a patient presenting in primary care or hospital outpatient settings has COVID-19 (Review)

Fever	Cross-sectional	Outpatient clinics/ED	4/803	36% to 88%	6% to 58%	2/4/0/2
		Hospital inpatients	3/294	47% to 80%	15% to 20%	3/2/0/0
		Unclear	-	-	-	-
		Primary care	2/968	33% to 49%	73% to 78%	1/1/1/1
		Outpatient clinics/ED	19/11691	7% to 94%	0% to 90%	4/19/1/2
	Case-control	Hospital inpatients	3/633	64% to 90%	19% to 48%	1/3/0/1
		Unclear	3/4656	22% to 85%	32% to 94%	0/2/0/0
		All settings (studies with prospective data collection only)	7/5548	54% (pooled summary estimate)	67% (pooled summary estimate)	
		Primary care	-	-	-	-
		Outpatient clinics/ED	4/803	37% to 75%	15% to 85%	2/4/0/2
Anosmia	Cross-sectional	Hospital inpatients	2/158	76% to 79%	7% to 7%	2/2/0/0
		Unclear	-	-	-	-
		Primary care	3/1784	26% to 43%	84% to 93%	1/2/1/1
		Outpatient clinics/ED	8/7768	10% to 65%	70% to 98%	1/7/0/1
		Hospital inpatients	-	-	-	-
	Case-control	Unclear	-	-	-	-
		All settings	11/9552	28% (pooled summary estimate)	93% (pooled summary estimate)	
		Primary care	-	-	-	-
		Outpatient clinics/ED	3/657	22% to 51%	96% to 97%	1/3/0/2
		Hospital inpatients	1/124	53%	83%	1/1/0/0
		Unclear	-	-	-	-

Ageusia	Cross-sectional	Primary care	2/1450	44% to 46%	84% to 85%	0/1/1/1
		Outpatient clinics/ED	4/5929	10% to 55%	70% to 100%	1/4/0/1
		Hospital inpatients	-	-	-	
		Unclear	-	-	-	
		All settings	6/7393	25% (pooled summary estimate)	91% (pooled summary estimate)	
	Case-control	Primary care	-	-	-	
		Outpatient clinics/ED	1/262	20%	95%	0/1/0/0
		Hospital inpatients	-	-	-	
		Unclear	-	-	-	
		All settings	6/8142	41% (pooled summary estimate)	91% (pooled summary estimate)	
Anosmia or ageusia	Cross-sectional	Primary care	1/816	59%	80%	0/1/0/0
		Outpatient clinics/ED	4/6590	16% to 49%	85% to 99%	0/4/0/0
		Hospital inpatients	-	-	-	
		Unclear	1/736	73%	75%	0/1/0/0
		All settings	6/8142	41% (pooled summary estimate)	91% (pooled summary estimate)	
	Case-control	Primary care	-	-	-	
		Outpatient clinics/ED	-	-	-	
		Hospital inpatients	-	-	-	
		Unclear	-	-	-	
		All settings	2/968	19% to 21%	61% to 72%	1/1/1/1
Sore throat	Cross-sectional	Primary care	2/968	19% to 21%	61% to 72%	1/1/1/1
		Outpatient clinics/ED	15/13,161	0% to 71%	30% to 99%	5/15/1/2
		Hospital inpatients	1/475	16%	88%	0/1/0/0

Unclear		2/1272	38% to 52%	34% to 45%	0/2/0/0
All settings		20/15,876	21% (pooled summary estimate)	70% (pooled summary estimate)	
Case-control					
Primary care		-	-	-	
Outpatient clinics/ED		3/657	17% to 45%	37% to 55%	1/3/0/2
Hospital inpatients		3/295	13% to 21%	55% to 91%	3/2/0/0
Unclear		-	-	-	
Myalgia					
Cross-sectional					
Primary care		1/334	26%	81%	1/1/0/0
Outpatient clinics/ED		9/6455	1% to 61%	53% to 99%	2/9/0/0
Hospital inpatients		2/580	5% to 12%	90% to 93%	0/2/0/1
Unclear		1/736	65%	33%	
All settings		13/8105	27% (pooled summary estimate)	83% (pooled summary estimate)	
Case-control					
Primary care		-	-	-	
Outpatient clinics/ED		1/268	57%	78%	1/1/0/1
Hospital inpatients		1/124	59%	30%	1/1/0/0
Unclear		-	-	-	
Fatigue					
Cross-sectional					
Primary care		2/968	19% to 59%	58% to 71%	1/1/1/1
Outpatient clinics/ED		9/4632	7% to 85%	39% to 94%	3/9/1/2
Hospital inpatients		1/53	10%	94%	1/1/0/0
Unclear		-	-	-	
All settings		12/5553	36% (pooled summary estimate)	75% (pooled summary estimate)	

Case-control	Primary care	-	-	-	-
	Outpatient clinics/ED	2/389	7% to 42%	69% to 85%	0/2/0/1
	Hospital inpatients	3/294	11% to 93%	13% to 100%	3/2/0/0
	Unclear	-	-	-	-
Headache	Primary care	2/968	11% to 40%	56% to 85%	1/1/1/1
	Outpatient clinics/ED	13/10941	3% to 78%	25% to 98%	3/13/1/2
	Hospital inpatients	2/528	12% to 15%	91% to 97%	1/2/0/0
	Unclear	1/736	85%	18%	0/1/0/0
	All settings (studies with prospective data collection only)	6/6171	22% (pooled summary estimate)	80% (pooled summary estimate)	
Case-control	Primary care	-	-	-	-
	Outpatient clinics/ED	3/657	18% to 65%	54% to 94%	1/3/0/2
	Hospital inpatients	2/158	11% to 73%	43% to 100%	2/2/0/0
	Unclear	-	-	-	-
Dyspnoea	Primary care	2/968	15% to 30%	75% to 82%	1/1/1/1
	Outpatient clinics/ED	19/12,198	0% to 73%	35% to 99%	5/19/1/2
	Hospital inpatients	1/475	10%	91%	0/1/0/0
	Unclear	2/1272	37% to 53%	34% to 66%	0/2/0/0
	All settings	24/14,913	25% (pooled summary estimate)	77% (pooled summary estimate)	
Case-control	Primary care	-	-	-	-
	Outpatient clinics/ED	3/657	12% to 42%	63% to 77%	1/3/0/2
	Hospital inpatients	1/124	34%	41%	1/1/0/0

Diarrhoea	Unclear	-	-	-	-
	Primary care	2/968	04% to 36%	72% to 93%	1/1/1/1
	Outpatient clinics/ED	14/10704	0% to 64%	74% to 99%	2/14/1/2
	Hospital inpatients	3/633	5% to 15%	88% to 97%	1/3/0/1
	Unclear	1/736	53%	62%	0/1/0/0
	All settings	20/13,016	12% (pooled summary estimate)	91% (pooled summary estimate)	
	Case-control	-	-	-	
	Primary care	4/1173	8% to 45%	77% to 92%	1/4/0/2
	Outpatient clinics/ED	2/158	5% to 40%	80% to 93%	2/2/0/0
	Hospital inpatients	-	-	-	
	Unclear	-	-	-	
	Primary care	-	-	-	
Anosmia or dysgeusia	Cross-sectional	2/457	9% to 74%	78% to 97%	0/2/0/0
	Outpatient clinics/ED	-	-	-	
	Hospital inpatients	-	-	-	
	Unclear	-	-	-	
	Primary care	-	-	-	
	Outpatient clinics/ED	1/268	65%	92%	1/1/0/1
Myalgia or arthralgia	Hospital inpatients	-	-	-	
	Unclear	-	-	-	
	Primary care	-	-	-	
	Outpatient clinics/ED	5/556	19% to 86%	35% to 91%	2/5/1/2
	Hospital inpatients	-	-	-	
	Primary care	-	-	-	

Signs and symptoms to determine if a patient presenting in primary care or hospital outpatient settings has COVID-19 (Review)

Case-control	Unclear	-	-	-	-
	Primary care	-	-	-	-
	Outpatient clinics/ED	1/262	34%	81%	0/1/0/0
	Hospital inpatients	-	-	-	-
	Unclear	-	-	-	-
Rhinorrhoea	Cross-sectional	-	-	-	-
	Primary care	-	-	-	-
	Outpatient clinics/ED	4/1777	5% to 62%	37% to 93%	1/4/0/0
	Hospital inpatients	1/475	4%	89%	0/1/0/0
	Unclear	-	-	-	-
Case-control	Primary care	-	-	-	-
	Outpatient clinics/ED	3/657	10% to 45%	46% to 80%	1/3/0/2
	Hospital inpatients	2/260	4% to 49%	44% to 95%	2/1/0/0
	Unclear	-	-	-	-
	ED: emergency department; RT-PCR: reverse transcription polymerase chain reaction				

BACKGROUND

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus and resulting COVID-19 pandemic present important diagnostic evaluation challenges. These range from, on the one hand, understanding the value of signs and symptoms in predicting possible infection, assessing whether existing biochemical and imaging tests can identify infection and recognise patients needing critical care, and on the other hand, evaluating whether new diagnostic tests can allow accurate rapid and point-of-care testing. Also, the diagnostic aims are diverse, including identifying current infection, ruling out infection, identifying people in need of care escalation, or testing for past infection and immunity.

This review is part of a suite of reviews on the diagnosis of SARS-CoV-2 infection and COVID-19 disease, and deals solely with the diagnostic accuracy of presenting clinical signs and symptoms.

Target condition being diagnosed

COVID-19 is the disease caused by infection with the SARS-CoV-2 virus. The key target conditions for this suite of reviews are current SARS-CoV-2 infection, current COVID-19, and past SARS-CoV-2 infection.

For current infection, the severity of the disease is important. SARS-CoV-2 infection can be asymptomatic (no symptoms); mild or moderate (symptoms such as fever, cough, aches, lethargy but without difficulty breathing at rest); severe (symptoms with breathlessness and increased respiratory rate indicative of pneumonia and oxygen need); or critical (requiring intensive support due to severe acute respiratory syndrome (SARS) or acute respiratory distress syndrome (ARDS), shock or other organ dysfunction). People with severe or critical disease require different patient management, which makes it important to distinguish between them.

Thus, there are three target conditions for current infection:

- SARS-CoV-2 infection (asymptomatic or symptomatic of any severity);
- mild or moderate COVID-19;
- severe or critical COVID-19.

In planning review updates, we will consider the potential addition of another grouping (which is a subset of the above):

- whether tests exist that identify people requiring respiratory support (SARS or ARDS) or intensive care.

Here we summarise the evidence on signs and symptoms; as a result asymptomatic SARS-CoV-2 and past SARS-CoV-2 infection are out of scope for this review.

Index test(s)

Signs and symptoms

Signs and symptoms are used in the initial diagnosis of suspected COVID-19, and to identify people with COVID-19 pneumonia. Symptoms are what is experienced by patients, for example, cough or nausea. Signs are what can be evaluated by clinical assessment, for example, lung auscultation findings, blood pressure or heart rate.

Key symptoms that have been associated with mild to moderate COVID-19 include: troublesome dry cough (for example, coughing more than usual over a one-hour period, or three or more coughing episodes in 24 hours), fever greater than 37.8 °C, diarrhoea, headache, breathlessness on light exertion, muscle pain, fatigue, and loss of sense of smell and taste. Red flags indicating possible severe disease or pneumonia include breathlessness at rest, loss of appetite, confusion, pain or pressure in the chest, and temperature above 38 °C.

Clinical pathway

Important in the context of COVID-19 is that the pathway is multifaceted because it is designed to care for the diseased individual and to protect the community from further spread. Decisions about patient and isolation pathways for COVID-19 vary according to health services and settings, available resources, and stages of the epidemic. They will change over time, if and when effective treatments and vaccines are identified. The decision points between these pathways vary, but all include points at which knowledge of the accuracy of diagnostic information is needed to be able to inform rational decision making.

Prior test(s)

In this review on signs and symptoms, no prior tests are required because signs and symptoms are used in the initial diagnosis of suspected COVID-19. Patients can, however, self-assess before presenting to healthcare services based on their symptoms. This is in contrast to contact tracing, in which patients or participants are tested based on a documented contact with a SARS-CoV-2-positive person and may themselves be asymptomatic.

Role of index test(s)

Signs and symptoms are used as triage tests, that is, to rule out COVID-19, but also to identify patients with possible COVID-19 who may require further testing, care escalation or isolation.

Alternative test(s)

Other Cochrane diagnostic test accuracy (DTA) reviews in the suite of reviews are addressing the following tests.

- Chest imaging (computed tomography (CT), chest X-ray and ultrasound; [Islam 2020](#))
- Routine laboratory testing, such as for C-reactive protein (CRP) and procalcitonin (PCT) ([Stegeman 2020](#))
- Antibody tests ([Deeks 2020a](#))
- Laboratory-independent point-of-care and near-patient molecular and antigen tests ([Dinnes 2020](#))
- Molecular laboratory tests (in preparation)

Rationale

It is essential to understand the accuracy of diagnostic tests including signs and symptoms to identify the best way they can be used in different settings to develop effective diagnostic and management pathways. We are producing a suite of Cochrane 'living systematic reviews', which will summarise evidence on the clinical accuracy of different tests and diagnostic features, grouped according to present research questions and settings, in the diagnosis of SARS-CoV-2 infection and COVID-19 disease. Summary estimates of accuracy from these reviews will help

inform diagnostic, screening, isolation, and patient management decisions.

New tests are being developed and evidence is emerging at an unprecedented rate during the COVID-19 pandemic. We will aim to update these reviews as often as is feasible to ensure that they provide the most up-to-date evidence about test accuracy.

These reviews are being produced rapidly to assist in providing a central resource of evidence to assist in the COVID-19 pandemic, summarising available evidence on the accuracy of the tests and presenting characteristics.

OBJECTIVES

To assess the diagnostic accuracy of signs and symptoms to determine if a person presenting in primary care or to hospital outpatient settings, such as the emergency department or dedicated COVID-19 clinics, has COVID-19.

Secondary objectives

Where data are available, we will investigate diagnostic accuracy (either by stratified analysis or meta-regression) according to:

- days since symptom onset;
- population (children; older adults);
- reference standard;
- study design; and
- setting.

Summary of previous review

In our initial review, we found 16 relevant studies with 7706 participants. The median number of participants was 134. Prevalence of the target disease varied from 5% to 38% with a median of 17%.

The studies assessed 27 separate signs and symptoms, but none assessed combinations of signs and symptoms. Seven were set in hospital outpatient clinics (2172 participants), four in emergency departments (1401 participants), but none in primary care settings. No studies included children, and only one focused on older adults. All the studies confirmed COVID-19 diagnosis by the most accurate test available, which was reverse transcription polymerase chain reaction (RT-PCR).

The studies did not clearly distinguish mild to moderate COVID-19 from severe to critical COVID-19, so we presented the results for all severities together. The results indicated that at least half of participants with COVID-19 had a cough, sore throat, high temperature, muscle or joint pain, fatigue, or headache. However, cough and sore throat were also common in people without COVID-19, so these symptoms alone are less helpful for diagnosing COVID-19. High temperature, muscle or joint pain, fatigue, and headache substantially increase the likelihood of COVID-19 when they are present.

Signs and symptoms for which sensitivity was reported above 50% in at least one study were the following:

- Cough: sensitivity between 43% to 71%, specificity between 14% to 54%

- Fever: sensitivity between 7% to 91%, specificity between 16% to 94%
- Sore throat: sensitivity between 5% to 71%, specificity between 55% to 80%
- Myalgia or arthralgia: sensitivity between 19% to 86%, specificity between 45% to 91%
- Fatigue: sensitivity between 10% to 57%, specificity between 60% to 94%
- Headache: sensitivity between 3% to 71%, specificity between 78% to 98%

All other signs and symptoms appeared to have very low sensitivities but high specificities, making them unsuitable for diagnosis individually.

We concluded that the diagnostic accuracy, especially the sensitivity, of individual signs and symptoms is low. In addition, results were highly variable across studies, making it difficult to draw firm conclusions.

New evidence since previous review

We retrieved 28 more studies on signs and symptoms in suspected COVID-19 patients, allowing pooling of the data for some features and estimation of summary measures of diagnostic accuracy. Moreover, this update contains new studies on the diagnostic value of olfactory symptoms, and includes a limited number of studies on combinations of symptoms.

Limitations of previous review

The main weakness of the initial review was the high risk of selection bias; many studies included patients who had already been admitted to hospital or who presented to hospital settings to seek treatment.

The lack of data on combinations of signs and symptoms was an important evidence gap. Consequently, there was no evidence on syndromic presentation and the value of composite signs and symptoms on the diagnostic accuracy measures.

Our search did not find any articles providing data on children. Children have been disproportionately underrepresented in the studies on diagnosing SARS-CoV-2 infection. Their absence seems related to the general mild presentation of the disease in the paediatric population and even more frequently the complete asymptomatic course. The full scope of disease presentation in children is however not known. Misclassification of children both at their presentation to the healthcare system and in the near future, where children will be asked to remain in quarantine when they present with predefined, but not yet evidence-based symptoms needs to be avoided to decrease the possible damage done to children's health.

Another important patient group is older adults. They are most at risk of a negative outcome of SARS-CoV-2 infection, especially mortality but also intensive care support. In the initial version of the review, only one study focused on adults aged 55 to 75 years. All other studies included adults of all ages and did not present results separately for the older age groups. The lack of a solid evidence base for the diagnosis of COVID-19 in older adults adds to the difficulty in diagnosing serious infections in this age group,

as other serious infections such as bacterial pneumonia or urinary sepsis also tend to lead to aspecific presentations.

METHODS

Criteria for considering studies for this review

Types of studies

We included studies of all designs that produce estimates of test accuracy or provide data from which estimates can be computed.

We included both single-gate (studies that recruit from a patient pathway before disease status has been ascertained, cross-sectional studies) and multi-gate (where people with and without the target condition are recruited separately) designs.

When interpreting the results we made sure that we carefully considered the limitations of different study designs, using quality assessment and analysis.

Studies had to have a sample size of a minimum of 10 participants.

Participants

Studies recruiting people presenting with a clinical suspicion of SARS-CoV-2 infection, based on a symptomatic presentation, were eligible. At least 50% of the study population had to present with COVID-19-compatible symptoms.

We kept the eligibility criteria purposely broad to include all patient groups and all variations of a test at this initial stage of reviewing the evidence (that is, if the patient population was unclear, we included the study).

Index tests

- All signs and symptoms, including:
 - * signs such as oxygen saturation, measured by oximetry and blood pressure;
 - * symptoms, such as fever or cough.
- We included combinations of signs and symptoms, but not when they were combined with laboratory, imaging, or other types of index tests as these will be covered in the other reviews.

Target conditions

To be eligible studies had to identify at least one of:

- mild or moderate COVID-19;
- severe or critical COVID-19 (including COVID-19 pneumonia).

Asymptomatic infection with SARS-CoV-2 is out of scope for this review, considering it is by definition not possible to detect this based on signs and symptoms.

Reference standards

We anticipated that studies would use a range of reference standards. Although RT-PCR is considered the best available test, due to rapidly evolving knowledge about the target conditions, multiple reference standards on their own as well as in combination have emerged.

We expected to encounter cases defined by:

- RT-PCR alone;

- RT-PCR, clinical expertise, and imaging (for example, CT thorax);
- repeated RT-PCR several days apart or from different samples;
- plaque reduction neutralisation test (PRNT) or enzyme-linked immunosorbent assay (ELISA) tests;
- information available at a subsequent time point;
- World Health Organization (WHO) and other case definitions (see [Appendix 1](#)).

This list is not exhaustive, and we recorded all reference standards encountered. With a group of methodological and clinical experts, we are producing a ranking of reference standards according to their ability to correctly classify participants using a consensus process.

Search methods for identification of studies

The final search date for this version of the review is 15 July 2020.

Electronic searches

We conducted a single literature search to cover our suite of Cochrane COVID-19 DTA reviews ([Deeks 2020b](#); [McInnes 2020](#)).

We used three different sources for our electronic searches to 15 July 2020, which were devised with the help of an experienced Cochrane Information Specialist with DTA expertise (RS). These searches aimed to identify all articles related to COVID-19 and SARS-CoV-2 and were not restricted to those evaluating symptoms and signs. Thus, the searches used no terms that specifically focused on an index test, diagnostic accuracy or study methodology.

Due to the increased volume of published and preprint articles, we used artificial intelligence text analysis from 25 May 2020 and onwards to conduct an initial classification of documents, based on their title and abstract information, for relevant and irrelevant documents. See [Appendix 2](#).

Cochrane COVID-19 Study Register searches

We also included searches undertaken by Cochrane to develop the Cochrane COVID-19 Study Register (covid-19.cochrane.org). These include searches of trials registers at US National Institutes of Health Ongoing Trials Register [ClinicalTrials.gov](https://clinicaltrials.gov) and the World Health Organization International Clinical Trials Registry Platform (apps.who.int/trialsearch), as well as PubMed.

Search strategies were designed for maximum sensitivity, to retrieve all human studies on COVID-19 and with no language limits. See [Appendix 3](#).

COVID-19 Living Evidence Database from the University of Bern

From 28 March 2020, we used the COVID-19 Living Evidence database from the Institute of Social and Preventive Medicine (ISPM) at the University of Bern (www.ispm.unibe.ch), as the primary source of records for the Cochrane COVID-19 DTA reviews. This search includes PubMed, Embase, and preprints indexed in bioRxiv and medRxiv databases. The strategies as described on the ISPM website are described here (ispmbern.github.io/covid-19/). See [Appendix 4](#).

The decision to focus primarily on the 'Bern' feed was due to the exceptionally large numbers of COVID-19 studies available only as preprints. The Cochrane COVID-19 Study Register has undergone a

number of iterations since the end of March 2020 and we anticipate moving back to the Cochrane COVID-19 Study Register as the primary source of records for subsequent review updates.

The Stephen B. Thacker CDC Library, COVID-19 Research Articles Downloadable Database

We included Embase records within the CDC library on COVID-19 Research Articles Database (see [Appendix 5](#) for details), and deduplicated these against the Cochrane COVID-19 Study Register.

Searching other resources

We also checked our search results against two additional repositories of COVID-19 publications including:

- the Evidence for Policy and Practice Information and Coordinating Centre (EPPI-Centre) 'COVID-19: Living map of the evidence' (eppi.ioe.ac.uk/COVID19_MAP/covid_map_v4.html);
- the Norwegian Institute of Public Health 'NIPH systematic and living map on COVID-19 evidence' (www.norkesk.no/forskningkart/NIPH_diagnosisMap.html)

Both of these repositories allow their contents to be filtered according to studies potentially relating to diagnosis, and both have agreed to provide us with updates of new diagnosis studies added. For this iteration of the review, we examined all diagnosis studies from both sources up to 15 July 2020.

We did not apply any language restrictions.

Data collection and analysis

Selection of studies

Pairs of review authors independently screened studies. We resolved disagreements by discussion with a third, experienced review author for initial title and abstract screening, and through discussion between three review authors for eligibility assessments.

Data extraction and management

Pairs of review authors independently performed data extraction. We resolved disagreements by discussion between three review authors.

We contacted study authors where we needed to clarify details or obtain missing information.

Assessment of methodological quality

Pairs of review authors independently assessed risk of bias and applicability concerns using the QUADAS-2 (Quality Assessment tool for Diagnostic Accuracy Studies) checklist, which was common to the suite of reviews but tailored to each particular review ([Whiting 2011](#); [Table 1](#)). For this review, we excluded the questions on the nature of the samples as these were not relevant, and we added a question on who assessed the signs. We resolved disagreements by discussion between three review authors.

Statistical analysis and data synthesis

We present results of estimated sensitivity and specificity using paired forest plots and summarised them in tables as appropriate.

We estimated summary sensitivity and specificity using a bivariate random-effects meta-analysis ([Macaskill 2013](#)), whenever five or more primary studies were available, and whenever heterogeneity across studies was deemed acceptable on visual inspection of the forest- and receiver operating characteristic (ROC) plots. We performed these analyses using data from studies with a cross-sectional design only.

We presented results of estimated sensitivity and specificity using paired forest plots in Review Manager 5 ([Review Manager 2020](#)), and tables as appropriate.

We considered tests to be useful in ruling out a serious infection in ambulatory care if their negative likelihood ratio (LR-) was lower than 0.20; conversely we considered diagnostic tests to be useful as 'red flags' for infections when their positive likelihood ratio (LR+) was 5.0 or higher ([Jaeschke 1994](#), [Van den Bruel 2010](#)).

We disaggregated data by study design, reporting results from cross-sectional studies separately from studies that used a multi-gate or other design that were assessed as prone to high risk of bias.

We undertook meta-analyses in R version 3.5.1 (lme4 package; [R 2020](#)).

Investigations of heterogeneity

We have listed sources of heterogeneity that we investigated if adequate data were available in the [Secondary objectives](#). In this version of the review, we used stratification to investigate heterogeneity as we considered it was inappropriate to combine studies. In future updates, if meta-analysis becomes possible, we will investigate heterogeneity through meta-regression.

In this version of the review we have stratified by study design only, as stratification by reference standard was not yet possible.

Sensitivity analyses

We aimed to undertake sensitivity analyses considering the impact of unpublished studies. However, this was not possible in this version of the review. We performed sensitivity analyses to investigate the impact of prospective versus retrospective data collection.

Assessment of reporting bias

We aimed to publish lists of studies that we know exist but for which we have not managed to locate reports, and request information to include in updates of these reviews. However, at the time of writing this version of the review, we are unaware of unpublished studies.

Summary of findings

We have listed our key findings in a 'Summary of findings' table to determine the strength of evidence for each test and findings, and to highlight important gaps in the evidence.

Updating

We will undertake monthly searches of published literature and preprints and, dependent on the number of new and important studies that we find, we will consider updating each review with each search if resources allow.

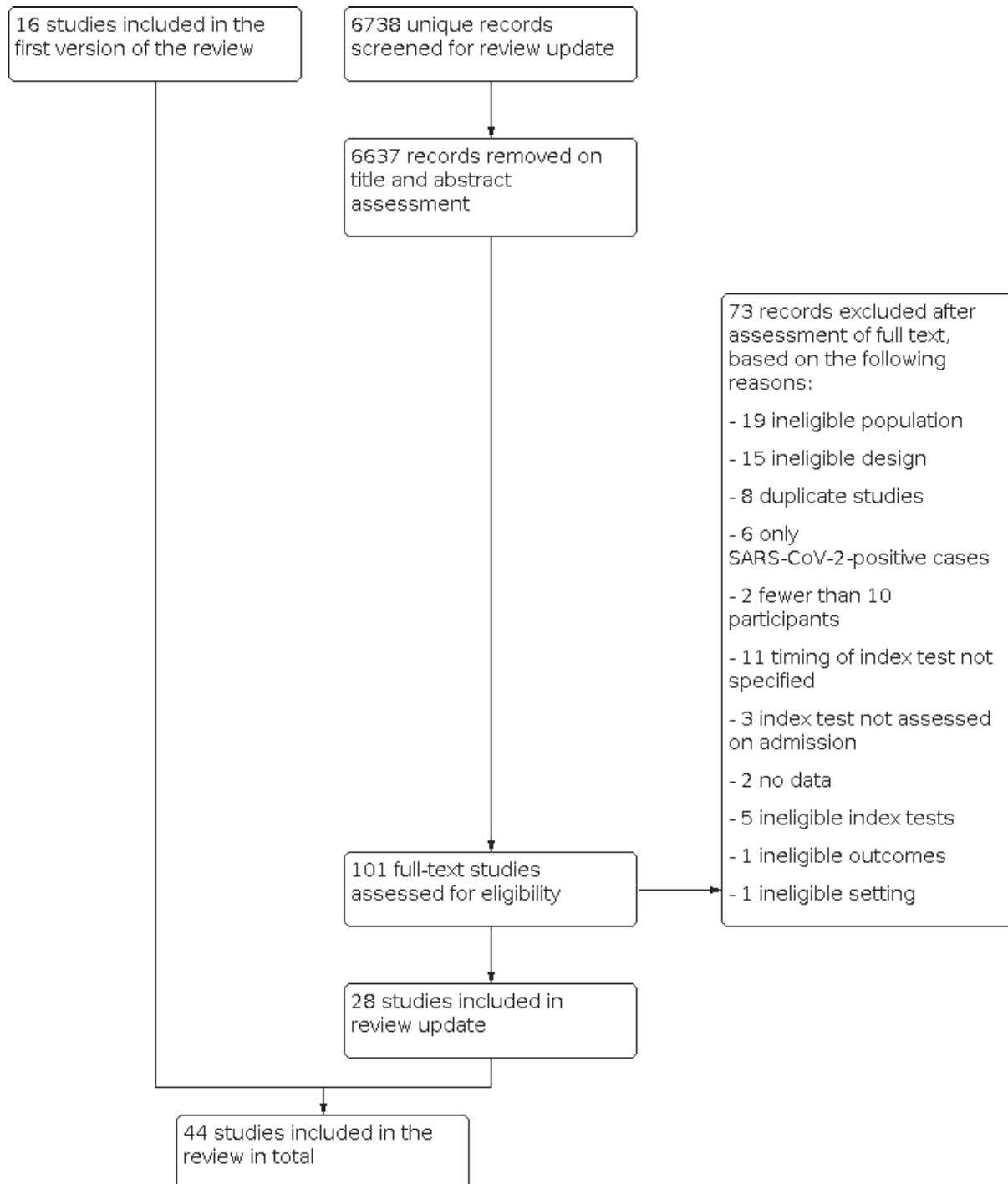
RESULTS

Results of the search

The first selection resulted in 7394 potentially eligible articles. This included the 658 articles that we screened in our initial review. After

screening on title and abstract, we excluded 7092 articles, leaving 302 full-text articles to be assessed. We included 44 articles in this version of the review, 16 of which were included in the initial review. The reasons for excluding 258 articles are listed in the flow chart (Figure 1; Moher 2009).

Figure 1. Flow diagram.



Two articles reported on the same cases (Chen 2020; Yang 2020), while using a different control group. Chen 2020 used a concurrent control group of pneumonia cases negative for SARS-CoV-2 on PCR testing but Yang 2020 used a historic control group of influenza pneumonia patients. For this reason we only included the Chen 2020 results in the analyses.

One study (Song 2020a), reported a study that included a derivation and validation part for the development of a prediction rule. The two parts are identical in set-up and only differ in respect to the time of data collection, that is, the derivation part recruited patients up to 5 February 2020 and the validation part recruited patients from 6 February 2020 onwards. As a result, we consider this to be one study and have entered all data on signs and symptoms as such.

A summary of the main study characteristics can be found in Table 2.

Methodological quality of included studies

The results of the quality assessment are summarised in Figure 2 and Figure 3. Of the 44 studies included in this review, six studies did not use a cross-sectional design. Four studies were case-control studies (Carignan 2020; Nobel 2020; Yang 2020; Zhao 2020), one study selected cases cross-sectionally in five hospitals but only selected controls in one hospital (Chen 2020), and one study emailed patients who had undergone testing for SARS-CoV-2 about olfactory symptoms prior to the SARS-CoV-2 test, with a response rate of 58% in SARS-CoV-2 positive cases and 15% in negative cases (Yan 2020).

Figure 2. 'Risk of bias' and applicability concerns graph: review authors' judgements about each domain presented as percentages across included studies

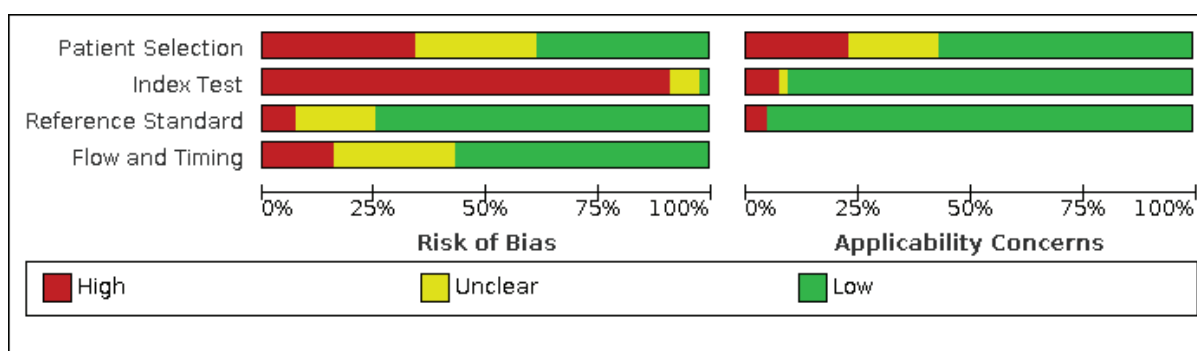
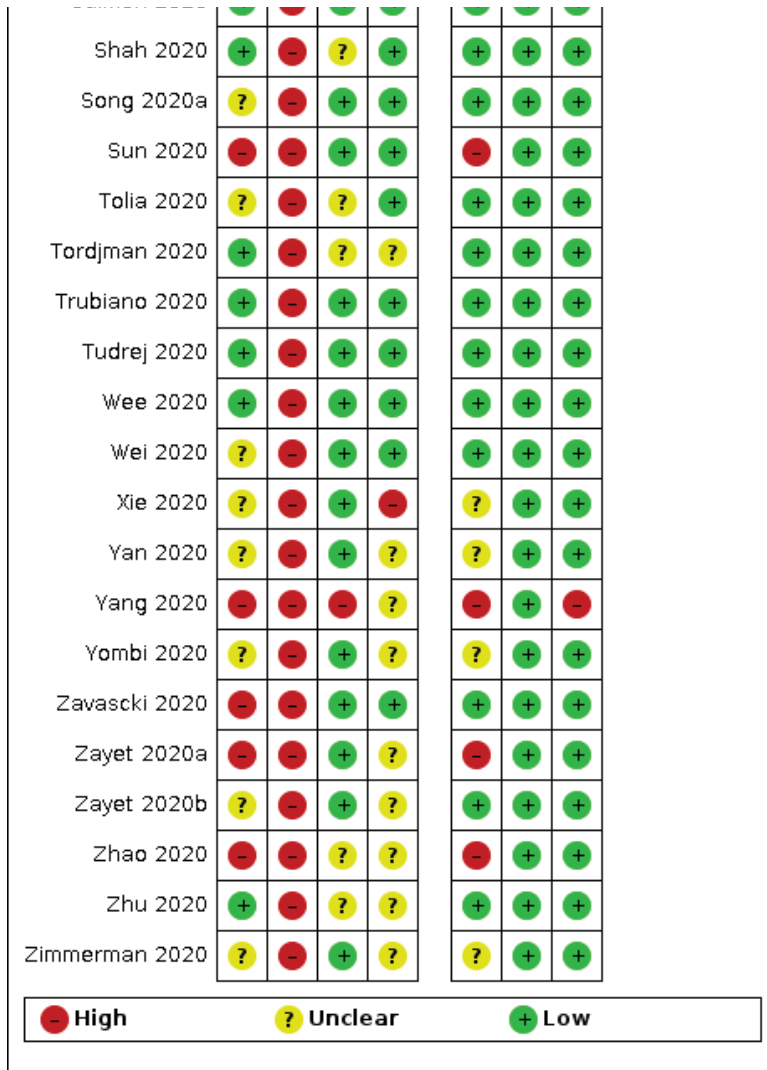


Figure 3. 'Risk of bias' and applicability concerns summary: review authors' judgements about each domain for each included study

	Risk of Bias				Applicability Concerns		
	Patient Selection	Index Test	Reference Standard	Flow and Timing	Patient Selection	Index Test	Reference Standard
Ahmed 2020	+	-	?	?	+	+	+
Al 2020	-	-	+	+	-	+	+
Brotons 2020	+	?	-	-	+	-	-
Carignan 2020	-	-	+	-	+	+	+
Challenger 2020	-	-	+	+	+	+	+
Chen 2020	-	?	+	+	-	?	+
Cheng 2020	-	-	+	+	-	+	+
Chua 2020	+	-	+	+	?	+	+
Clemency 2020	+	-	+	+	+	+	+
Feng 2020	+	-	-	-	+	+	+
Gilbert 2020	-	-	+	+	-	+	+
Haehner 2020	+	+	+	+	+	+	+
Huang 2020	?	-	+	+	+	+	+
Just 2020	-	-	+	+	+	+	+
Leal 2020	-	-	?	-	-	-	+
Lee 2020	?	-	+	-	?	-	+
Liang 2020	-	-	+	-	-	+	+
Mao 2020	-	-	+	?	+	+	+
Nobel 2020	+	-	+	+	+	+	+
O'Reilly 2020	+	-	+	+	+	+	+
Peng 2020	?	-	+	+	?	+	+
Peyrony 2020	?	-	+	+	?	+	+
Pisapia 2020	+	-	+	?	+	+	+
Rentsch 2020	+	?	?	+	?	+	+
Salmon 2020	+	-	+	+	+	+	+
Shah 2020	+	-	?	+	+	+	+

Figure 3. (Continued)



We rated patient selection as high risk of bias in 15 out of 44 studies. In five studies ([Ai 2020](#); [Chen 2020](#); [Cheng 2020](#); [Liang 2020](#); [Yang 2020](#)) this was because a CT scan or other imaging was used to diagnose patients with pneumonia prior to inclusion in the study. RT-PCR results were then used to distinguish between COVID-19 pneumonia and pneumonia from other causes. For all studies, testing was highly dependent on the local case definition and testing criteria that was in effect at the time of the study, meaning all patients that were included in studies had already gone through a referral or selection filter. The most extreme example of this is [Liang 2020](#), in which patients with radiological evidence of pneumonia and a clinical presentation compatible with COVID-19 were only tested for SARS-CoV-2 after a panel discussion.

We rated all studies except four as high risk of bias for the index tests because there was little to no detail on how, by whom and when the signs and symptoms were measured. [Table 3](#) describes how studies measured olfactory symptoms. Studies collected information about symptoms in different ways: interviews by

telephone or in person using standardised questionnaires, online surveys, self-reporting at presentation, or systematic assessment by staff at enrolment without standardisation. Unfortunately, the standardised questionnaires themselves are rarely reported, and are often newly developed by each research team.

In addition, there was considerable uncertainty around the reference standard, with some studies providing little detail on the RT-PCR tests that were used or lack of clarity on blinding.

Patient flow was unclear in 12 studies (Ahmed 2020; Mao 2020; Pisapia 2020; Tordjman 2020; Yan 2020; Yang 2020; Yombi 2020; Zayet 2020a; Zayet 2020b; Zhao 2020; Zhu 2020; Zimmerman 2020), either because the timing of recording signs and symptoms and conduct of the reference standard was unclear, or because some patients received a second or third reference standard at unclear time points during hospital admission, or because participant records were deleted when they contained missing data.

Findings

The main characteristics of all included studies are listed in [Table 2](#).

There were seven studies in hospital inpatients ([Ai 2020](#); [Chen 2020](#); [Huang 2020](#); [Xie 2020](#); [Yang 2020](#); [Zayet 2020a](#); [Zhao 2020](#)), twelve studies in hospital outpatients ([Carignan 2020](#); [Cheng 2020](#); [Liang 2020](#); [Mao 2020](#); [Nobel 2020](#); [Peng 2020](#); [Song 2020a](#); [Sun 2020](#); [Wei 2020](#); [Yan 2020](#); [Zavascki 2020](#); [Zayet 2020b](#)), ten studies in emergency departments (EDs) ([Feng 2020](#); [Chua 2020](#); [O'Reilly 2020](#); [Peyrony 2020](#); [Pisapia 2020](#); [Shah 2020](#); [Tolia 2020](#); [Tordjman 2020](#); [Wee 2020](#); [Zhu 2020](#)), three studies in primary care settings ([Brotons 2020](#); [Just 2020](#); [Tudrej 2020](#)), and nine studies in other outpatient settings such as drive-through testing sites ([Ahmed 2020](#); [Challener 2020](#); [Clemency 2020](#); [Gilbert 2020](#); [Haehner 2020](#); [Haehner 2020](#); [Lee 2020](#); [Salmon 2020](#); [Trubiano 2020](#)). Three studies did not specify setting ([Rentsch 2020](#); [Yombi 2020](#); [Zimmerman 2020](#)).

Nine studies assessed accuracy of signs and symptoms for the diagnosis of COVID-19 pneumonia ([Ai 2020](#); [Chen 2020](#); [Cheng 2020](#); [Feng 2020](#); [Liang 2020](#); [Tordjman 2020](#); [Xie 2020](#); [Yang 2020](#); [Zhao](#)

[2020](#)), the remaining studies had SARS-CoV-2 infection as the target condition. The distinction between these two target conditions was not always very clear though, and a degree of overlap is to be assumed. All but one study used RT-PCR testing as reference standard ([Brotons 2020](#)), with some variation in the samples that were used. [Brotons 2020](#) used positive serology for SARS-CoV-2 (IgM and/or IgG) at the time of presentation and presence of symptoms and signs in the previous month as a reference standard.

There were 26,884 participants included in all studies, the median number of participants was 345. Prevalence varied from 3% to 71% with a median of 21% (cross-sectional studies).

We found data on 84 signs and symptoms, which fall into six different categories, that is, upper respiratory, lower respiratory, systemic, gastro-intestinal, cardiovascular and olfactory signs and symptoms. Results for the single-gate (cross-sectional) studies are presented in forest plots ([Figure 4](#); [Figure 5](#); [Figure 6](#); [Figure 7](#); [Figure 8](#); [Figure 9](#)), and are plotted in ROC space ([Figure 10](#); [Figure 11](#); [Figure 12](#); [Figure 13](#); [Figure 14](#); [Figure 15](#); [Figure 16](#); [Figure 17](#); [Figure 18](#); [Figure 19](#); [Figure 20](#); [Figure 21](#); [Figure 22](#)). Results of multi-gate (non-cross-sectional studies) are presented in forest plots only ([Figure 23](#); [Figure 24](#); [Figure 25](#); [Figure 26](#); [Figure 27](#)).

Figure 4. Forest plot of upper respiratory tract symptoms (cross-sectional studies)

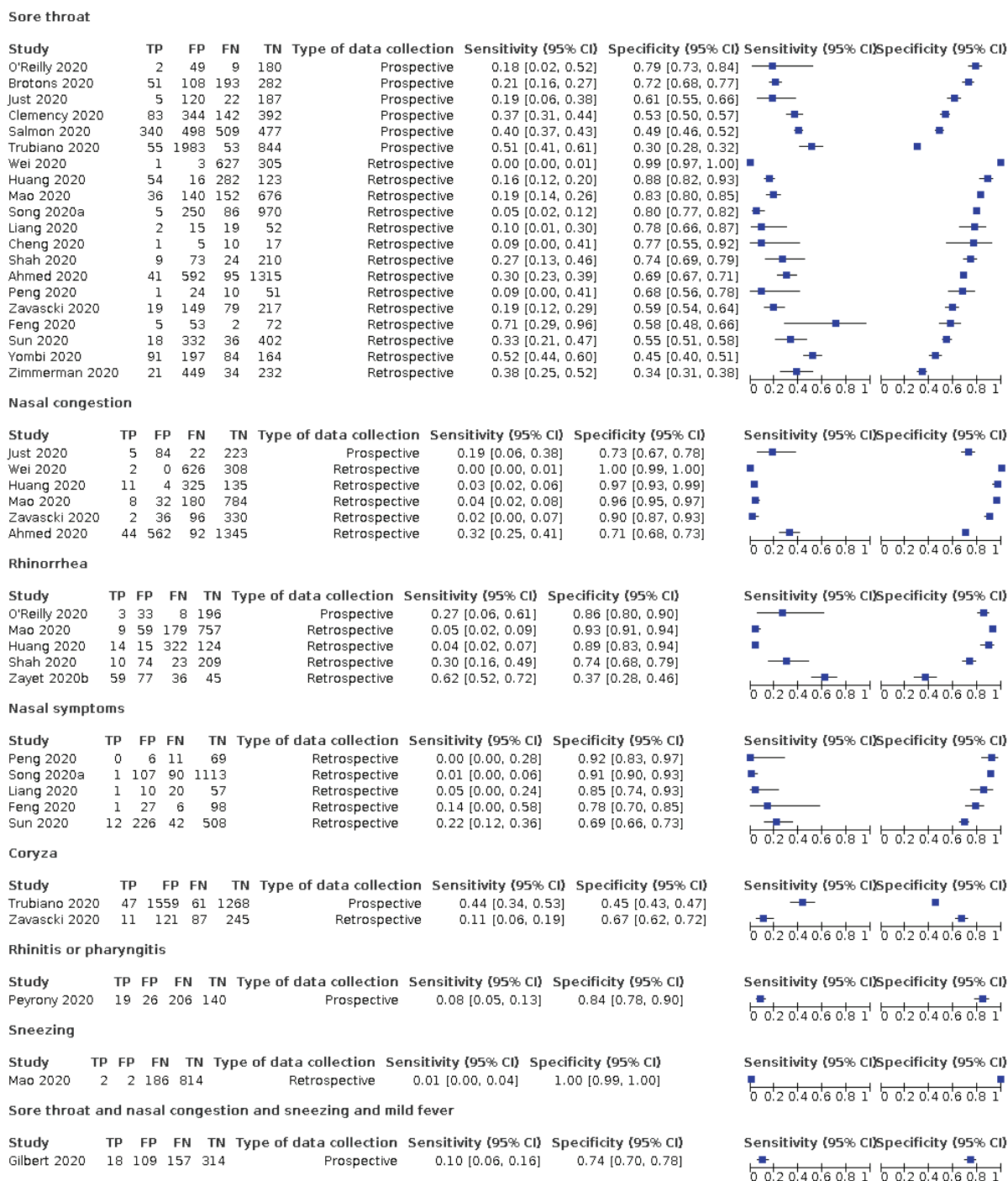


Figure 5. Forest plot of lower respiratory tract symptoms (cross-sectional studies)

Cough

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
O'Reilly 2020	6	102	5	127	Prospective	0.55 [0.23, 0.83]	0.55 [0.49, 0.62]		
Peyrony 2020	158	81	67	85	Prospective	0.70 [0.64, 0.76]	0.51 [0.43, 0.59]		
Brotons 2020	128	208	116	182	Prospective	0.52 [0.46, 0.59]	0.47 [0.42, 0.52]		
Al 2020	11	19	9	14	Prospective	0.55 [0.32, 0.77]	0.42 [0.25, 0.61]		
Salmon 2020	598	659	251	316	Prospective	0.70 [0.67, 0.73]	0.32 [0.29, 0.35]		
Trubiano 2020	86	1956	22	871	Prospective	0.80 [0.71, 0.87]	0.31 [0.29, 0.33]		
Just 2020	19	214	8	93	Prospective	0.70 [0.50, 0.86]	0.30 [0.25, 0.36]		
Wei 2020	98	65	530	243	Retrospective	0.16 [0.13, 0.19]	0.79 [0.74, 0.83]		
Song 2020a	55	562	36	658	Retrospective	0.60 [0.50, 0.71]	0.54 [0.51, 0.57]		
Feng 2020	5	60	2	65	Retrospective	0.71 [0.29, 0.96]	0.52 [0.43, 0.61]		
Peng 2020	6	46	5	29	Retrospective	0.55 [0.23, 0.83]	0.39 [0.28, 0.51]		
Zhu 2020	21	52	11	32	Retrospective	0.66 [0.47, 0.81]	0.38 [0.28, 0.49]		
Mao 2020	116	506	72	310	Retrospective	0.62 [0.54, 0.69]	0.38 [0.35, 0.41]		
Yombi 2020	136	229	39	132	Retrospective	0.78 [0.71, 0.84]	0.37 [0.32, 0.42]		
Xie 2020	11	55	10	29	Retrospective	0.52 [0.30, 0.74]	0.35 [0.24, 0.46]		
Zavascki 2020	68	244	30	122	Retrospective	0.69 [0.59, 0.78]	0.33 [0.29, 0.38]		
Sun 2020	36	528	18	206	Retrospective	0.67 [0.53, 0.79]	0.28 [0.25, 0.31]		
Shah 2020	28	208	5	75	Retrospective	0.85 [0.68, 0.95]	0.27 [0.21, 0.32]		
Tordjman 2020	43	39	7	11	Retrospective	0.86 [0.73, 0.94]	0.22 [0.12, 0.36]		
Zayet 2020b	75	96	20	26	Retrospective	0.79 [0.69, 0.87]	0.21 [0.14, 0.30]		
Liang 2020	9	53	12	14	Retrospective	0.43 [0.22, 0.66]	0.21 [0.12, 0.33]		
Pisapia 2020	12	16	5	4	Retrospective	0.71 [0.44, 0.90]	0.20 [0.06, 0.44]		
Cheng 2020	7	19	4	3	Retrospective	0.64 [0.31, 0.89]	0.14 [0.03, 0.35]		
Zimmerman 2020	47	592	8	89	Retrospective	0.85 [0.73, 0.94]	0.13 [0.11, 0.16]		
Ahmed 2020	121	1697	15	210	Retrospective	0.89 [0.82, 0.94]	0.11 [0.10, 0.13]		



Dyspnoea

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Just 2020	4	56	23	251	Prospective	0.15 [0.04, 0.34]	0.82 [0.77, 0.86]		
Brotons 2020	72	98	172	292	Prospective	0.30 [0.24, 0.36]	0.75 [0.70, 0.79]		
Trubiano 2020	29	868	79	1959	Prospective	0.27 [0.19, 0.36]	0.69 [0.68, 0.71]		
Peyrony 2020	131	66	94	100	Prospective	0.58 [0.51, 0.65]	0.60 [0.52, 0.68]		
Clemency 2020	83	318	142	418	Prospective	0.37 [0.31, 0.44]	0.57 [0.53, 0.60]		
O'Reilly 2020	8	114	3	115	Prospective	0.73 [0.39, 0.94]	0.50 [0.44, 0.57]		
Wei 2020	6	2	622	306	Retrospective	0.01 [0.00, 0.02]	0.99 [0.98, 1.00]		
Zhu 2020	3	2	29	82	Retrospective	0.09 [0.02, 0.25]	0.98 [0.92, 1.00]		
Mao 2020	12	51	176	765	Retrospective	0.06 [0.03, 0.11]	0.94 [0.92, 0.95]		
Huang 2020	33	12	303	127	Retrospective	0.10 [0.07, 0.14]	0.91 [0.85, 0.95]		
Song 2020a	23	111	68	1109	Retrospective	0.25 [0.17, 0.35]	0.91 [0.89, 0.92]		
Sun 2020	7	93	47	641	Retrospective	0.13 [0.05, 0.25]	0.87 [0.85, 0.90]		
Peng 2020	0	10	11	65	Retrospective	0.00 [0.00, 0.28]	0.87 [0.77, 0.93]		
Feng 2020	0	18	7	107	Retrospective	0.00 [0.00, 0.41]	0.86 [0.78, 0.91]		
Liang 2020	1	11	20	56	Retrospective	0.05 [0.00, 0.24]	0.84 [0.73, 0.92]		
Cheng 2020	1	4	10	18	Retrospective	0.09 [0.00, 0.41]	0.82 [0.60, 0.95]		
Pisapia 2020	7	4	10	16	Retrospective	0.41 [0.18, 0.67]	0.80 [0.56, 0.94]		
Zavascki 2020	41	84	57	282	Retrospective	0.42 [0.32, 0.52]	0.77 [0.72, 0.81]		
Yombi 2020	65	122	110	239	Retrospective	0.37 [0.30, 0.45]	0.66 [0.61, 0.71]		
Zayet 2020b	40	50	55	72	Retrospective	0.42 [0.32, 0.53]	0.59 [0.50, 0.68]		
Shah 2020	23	171	10	112	Retrospective	0.70 [0.51, 0.84]	0.40 [0.34, 0.46]		
Tordjman 2020	35	31	15	19	Retrospective	0.70 [0.55, 0.82]	0.38 [0.25, 0.53]		
Ahmed 2020	68	1239	68	668	Retrospective	0.50 [0.41, 0.59]	0.35 [0.33, 0.37]		
Zimmerman 2020	29	449	26	232	Retrospective	0.53 [0.39, 0.66]	0.34 [0.31, 0.38]		



Sputum production

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Clemency 2020	35	111	190	625	Prospective	0.16 [0.11, 0.21]	0.85 [0.82, 0.87]		
Wei 2020	1	0	627	308	Retrospective	0.00 [0.00, 0.01]	1.00 [0.99, 1.00]		
Song 2020a	24	166	67	1054	Retrospective	0.26 [0.18, 0.37]	0.86 [0.84, 0.88]		
Zhu 2020	5	17	27	67	Retrospective	0.16 [0.05, 0.33]	0.80 [0.70, 0.88]		
Sun 2020	13	199	41	535	Retrospective	0.24 [0.13, 0.38]	0.73 [0.70, 0.76]		
Shah 2020	10	77	23	206	Retrospective	0.30 [0.16, 0.49]	0.73 [0.67, 0.78]		
Feng 2020	2	36	4	89	Retrospective	0.33 [0.04, 0.78]	0.71 [0.62, 0.79]		
Huang 2020	122	48	214	91	Retrospective	0.36 [0.31, 0.42]	0.65 [0.57, 0.73]		
Xie 2020	2	34	19	50	Retrospective	0.10 [0.01, 0.30]	0.60 [0.48, 0.70]		
Liang 2020	7	30	14	37	Retrospective	0.33 [0.15, 0.57]	0.55 [0.43, 0.67]		
Cheng 2020	3	11	8	11	Retrospective	0.27 [0.06, 0.61]	0.50 [0.28, 0.72]		



Chest tightness

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Trubiano 2020	3	68	105	2759	Prospective	0.03 [0.01, 0.08]	0.98 [0.97, 0.98]		
Peyrony 2020	11	13	214	153	Prospective	0.05 [0.02, 0.09]	0.92 [0.87, 0.96]		
Mao 2020	4	19	184	797	Retrospective	0.02 [0.01, 0.05]	0.98 [0.96, 0.99]		
Wei 2020	15	10	613	298	Retrospective	0.02 [0.01, 0.04]	0.97 [0.94, 0.98]		
Huang 2020	27	6	309	133	Retrospective	0.08 [0.05, 0.11]	0.96 [0.91, 0.98]		
Shah 2020	5	81	28	202	Retrospective	0.15 [0.05, 0.32]	0.71 [0.66, 0.77]		



Figure 5. (Continued)

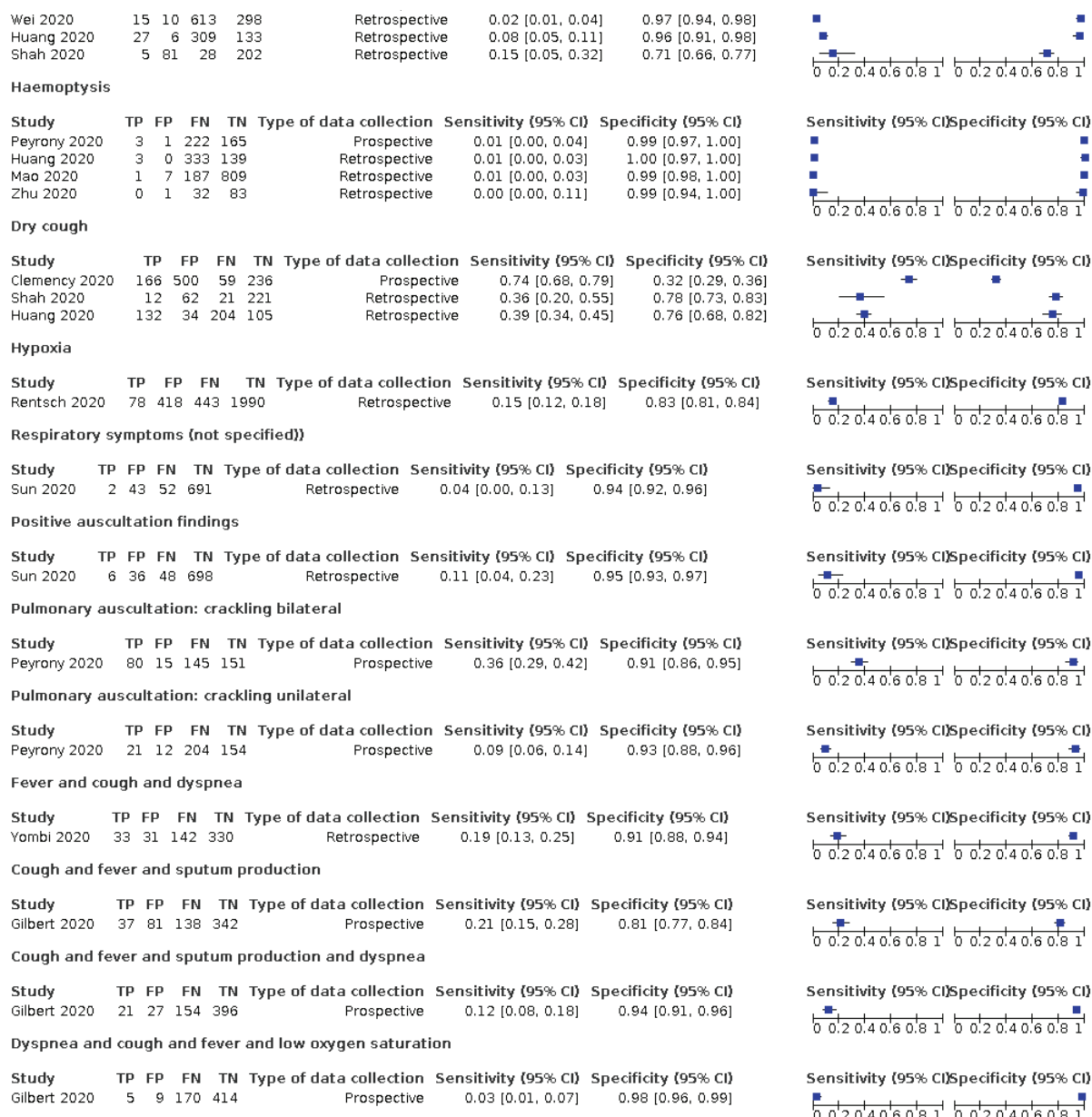


Figure 6. Forest plot of systemic signs and symptoms (cross-sectional studies)

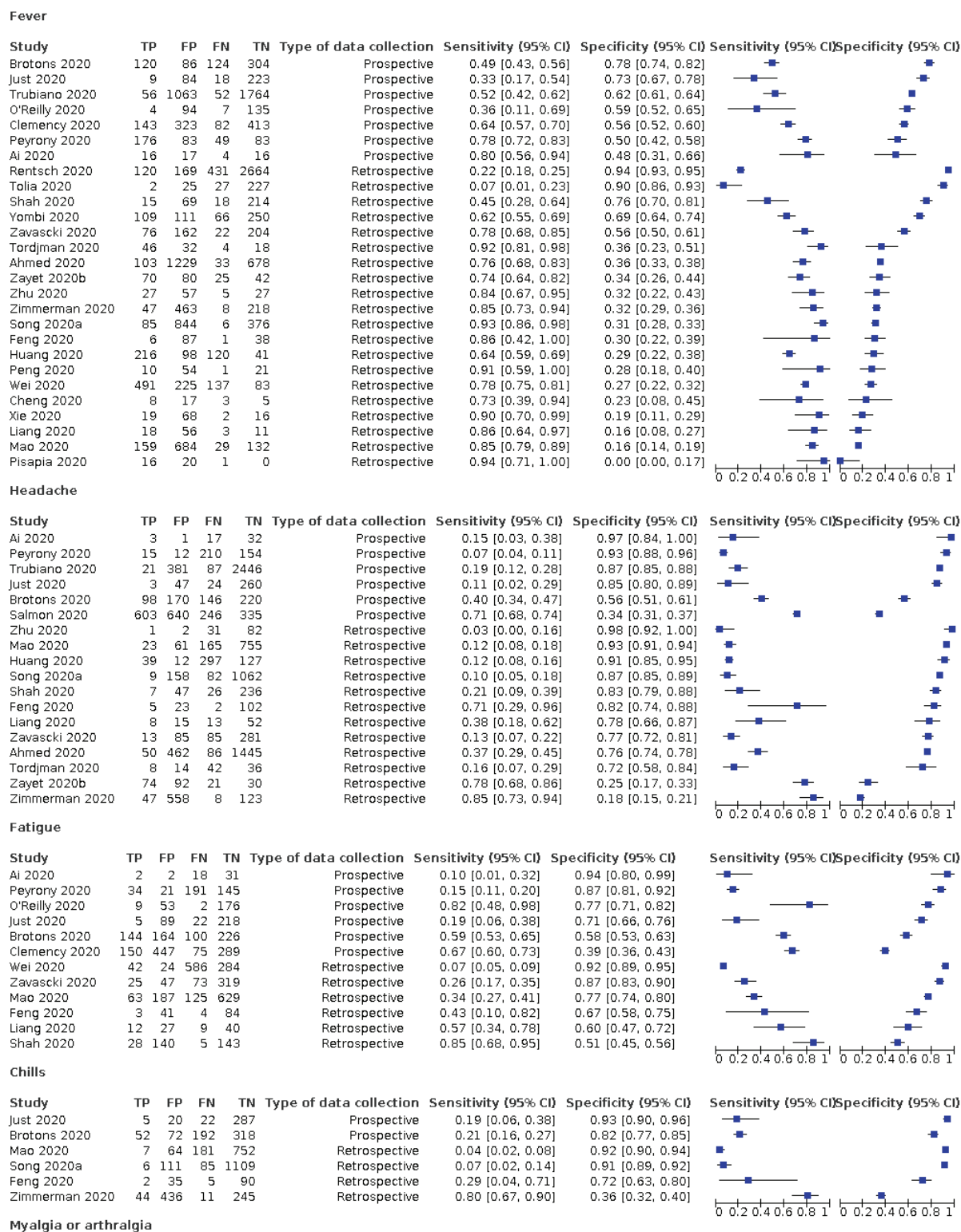
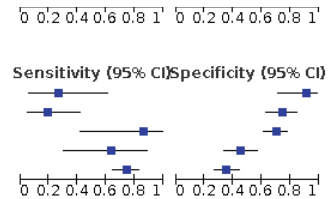


Figure 6. (Continued)

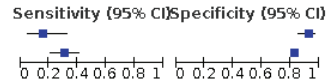
Myalgia or arthralgia

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)
Cheng 2020	3	2	8	20	Retrospective	0.27 [0.06, 0.61]	0.91 [0.71, 0.99]
Liang 2020	4	17	17	50	Retrospective	0.19 [0.05, 0.42]	0.75 [0.63, 0.84]
Feng 2020	6	37	1	88	Retrospective	0.86 [0.42, 1.00]	0.70 [0.62, 0.78]
Peng 2020	7	41	4	34	Retrospective	0.64 [0.31, 0.89]	0.45 [0.34, 0.57]
Zayet 2020b	71	79	24	43	Retrospective	0.75 [0.65, 0.83]	0.35 [0.27, 0.44]



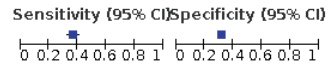
Myalgia or fatigue

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)
Zhu 2020	5	6	27	78	Retrospective	0.16 [0.05, 0.33]	0.93 [0.85, 0.97]
Song 2020a	28	214	63	1006	Retrospective	0.31 [0.22, 0.41]	0.82 [0.80, 0.85]



Low body temperature

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)
Rentsch 2020	204	1938	347	895	Retrospective	0.37 [0.33, 0.41]	0.32 [0.30, 0.33]



Shivers

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)
Feng 2020	1	17	6	108	Retrospective	0.14 [0.00, 0.58]	0.86 [0.79, 0.92]

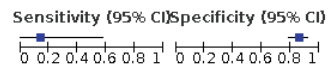
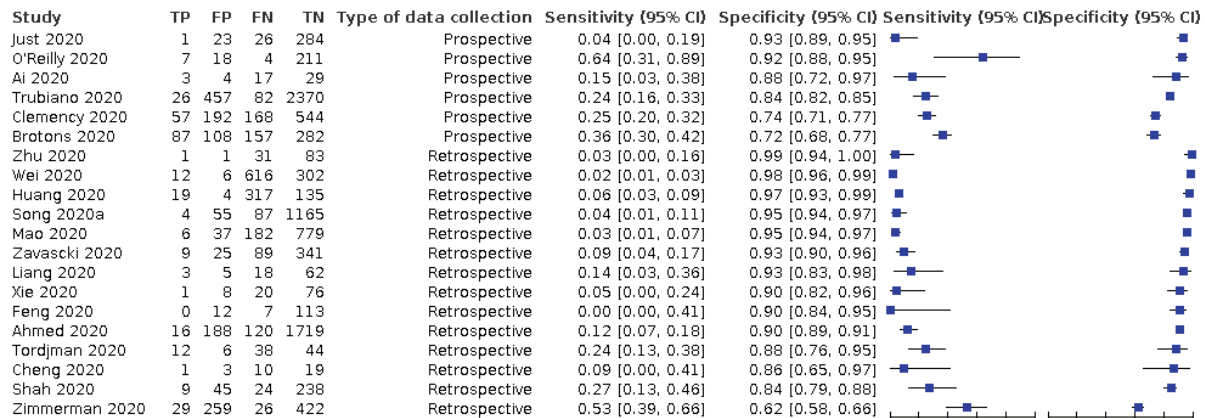
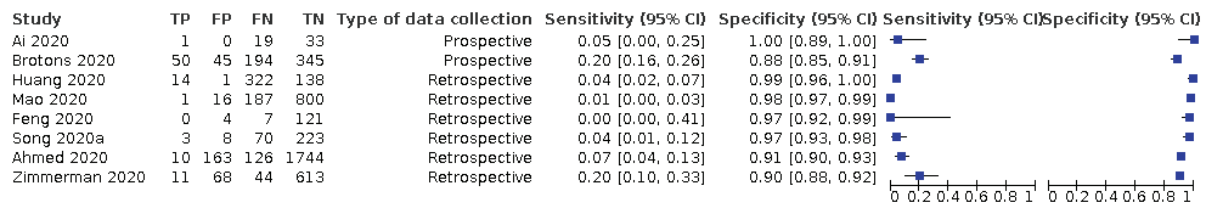


Figure 7. Forest plot of gastrointestinal signs and symptoms (cross-sectional studies)

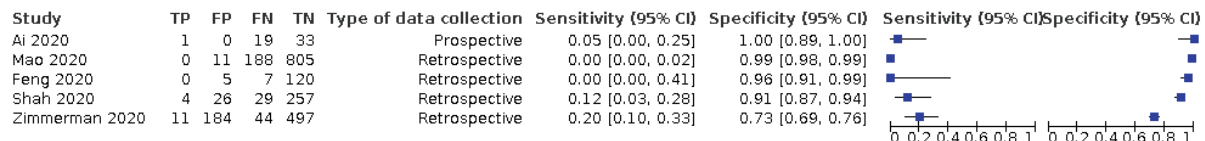
Diarrhoea



Nausea or vomiting



Abdominal pain



Gastrointestinal symptoms (not specified)

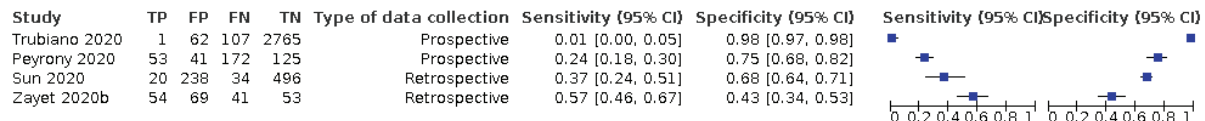


Figure 8. Forest plot of cardiovascular signs and symptoms (cross-sectional studies)

Tachycardia

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Rentsch 2020	257	1083	295	1738	Retrospective	0.47 [0.42, 0.51]	0.62 [0.60, 0.63]		
Shah 2020	16	164	17	119	Retrospective	0.48 [0.31, 0.66]	0.42 [0.36, 0.48]		

Low systolic blood pressure

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Rentsch 2020	63	292	485	2501	Retrospective	0.11 [0.09, 0.14]	0.90 [0.88, 0.91]		

High systolic blood pressure

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Rentsch 2020	211	1210	337	1583	Retrospective	0.39 [0.34, 0.43]	0.57 [0.55, 0.59]		

Palpitations

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Feng 2020	0	3	7	122	Retrospective	0.00 [0.00, 0.41]	0.98 [0.93, 1.00]		

Figure 9. Forest plot of olfactory symptoms (cross-sectional studies)

Anosmia

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Peyrony 2020	31	3	194	163	Prospective	0.14 [0.10, 0.19]	0.98 [0.95, 1.00]		
Trubiano 2020	11	64	97	2763	Prospective	0.10 [0.05, 0.17]	0.98 [0.97, 0.98]		
Salmon 2020	149	41	700	934	Prospective	0.18 [0.15, 0.20]	0.96 [0.94, 0.97]		
Just 2020	7	22	20	285	Prospective	0.26 [0.11, 0.46]	0.93 [0.89, 0.95]		
Haehner 2020	22	47	12	419	Prospective	0.65 [0.46, 0.80]	0.90 [0.87, 0.92]		
Tudrej 2020	82	74	116	544	Prospective	0.41 [0.34, 0.49]	0.88 [0.85, 0.90]		
Brottons 2020	104	62	140	328	Prospective	0.43 [0.36, 0.49]	0.84 [0.80, 0.88]		
Leal 2020	249	192	195	448	Prospective	0.56 [0.51, 0.61]	0.70 [0.66, 0.74]		
Tordjman 2020	5	1	45	49	Retrospective	0.10 [0.03, 0.22]	0.98 [0.89, 1.00]		
Chua 2020	4	14	27	672	Retrospective	0.13 [0.04, 0.30]	0.98 [0.97, 0.99]		
Zayet 2020b	60	18	35	104	Retrospective	0.63 [0.53, 0.73]	0.85 [0.78, 0.91]		

Ageusia

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Trubiano 2020	12	69	96	2758	Prospective	0.11 [0.06, 0.19]	0.98 [0.97, 0.98]		
Salmon 2020	116	74	733	901	Prospective	0.14 [0.11, 0.16]	0.92 [0.91, 0.94]		
Brottons 2020	107	60	137	330	Prospective	0.44 [0.38, 0.50]	0.85 [0.81, 0.88]		
Tudrej 2020	92	96	106	522	Prospective	0.46 [0.39, 0.54]	0.84 [0.81, 0.87]		
Leal 2020	235	192	209	448	Prospective	0.53 [0.48, 0.58]	0.70 [0.66, 0.74]		
Tordjman 2020	5	0	45	50	Retrospective	0.10 [0.03, 0.22]	1.00 [0.93, 1.00]		

Anosmia or ageusia

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Wee 2020	35	9	119	707	Prospective	0.23 [0.16, 0.30]	0.99 [0.98, 0.99]		
Trubiano 2020	17	109	91	2718	Prospective	0.16 [0.09, 0.24]	0.96 [0.95, 0.97]		
Salmon 2020	346	95	503	880	Prospective	0.41 [0.37, 0.44]	0.90 [0.88, 0.92]		
Clemency 2020	110	108	115	628	Prospective	0.49 [0.42, 0.56]	0.85 [0.83, 0.88]		
Tudrej 2020	116	126	82	492	Prospective	0.59 [0.51, 0.66]	0.80 [0.76, 0.83]		
Zimmerman 2020	40	170	15	511	Retrospective	0.73 [0.59, 0.84]	0.75 [0.72, 0.78]		

Anosmia and ageusia

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Salmon 2020	314	66	535	909	Prospective	0.37 [0.34, 0.40]	0.93 [0.91, 0.95]		
Tudrej 2020	58	44	140	574	Prospective	0.29 [0.23, 0.36]	0.93 [0.91, 0.95]		

Anosmia or dysgeusia

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
O'Reilly 2020	1	7	10	222	Prospective	0.09 [0.00, 0.41]	0.97 [0.94, 0.99]		
Zayet 2020b	70	27	25	95	Retrospective	0.74 [0.64, 0.82]	0.78 [0.69, 0.85]		

Dysgeusia

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zayet 2020b	62	19	33	103	Retrospective	0.65 [0.55, 0.75]	0.84 [0.77, 0.90]		

Anosmia and dysgeusia

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zayet 2020b	52	11	43	111	Retrospective	0.55 [0.44, 0.65]	0.91 [0.84, 0.95]		

Figure 10. Summary ROC plot of upper respiratory tract symptoms (cross-sectional studies)

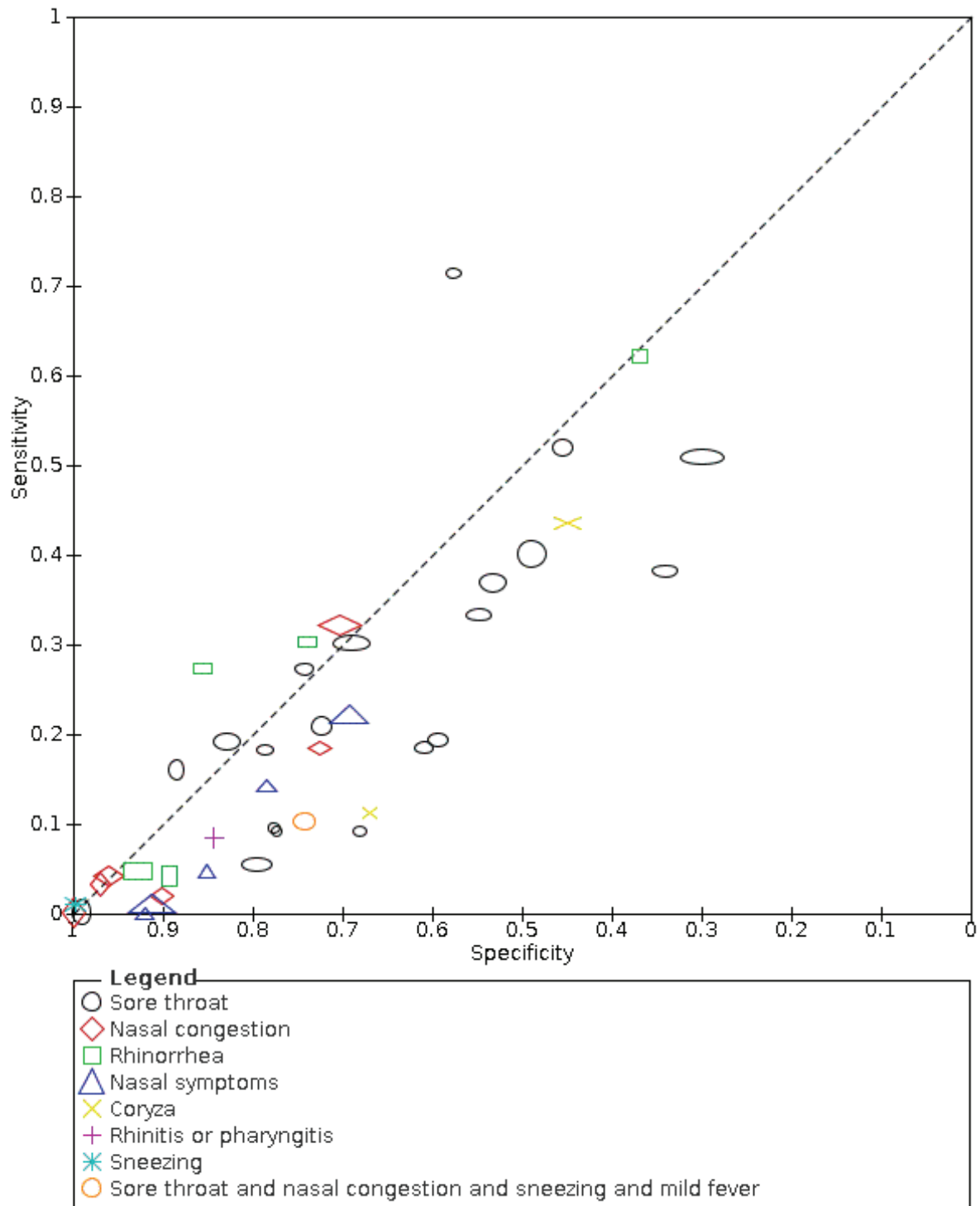


Figure 11. Summary ROC plot of lower respiratory tract symptoms (cross-sectional studies)

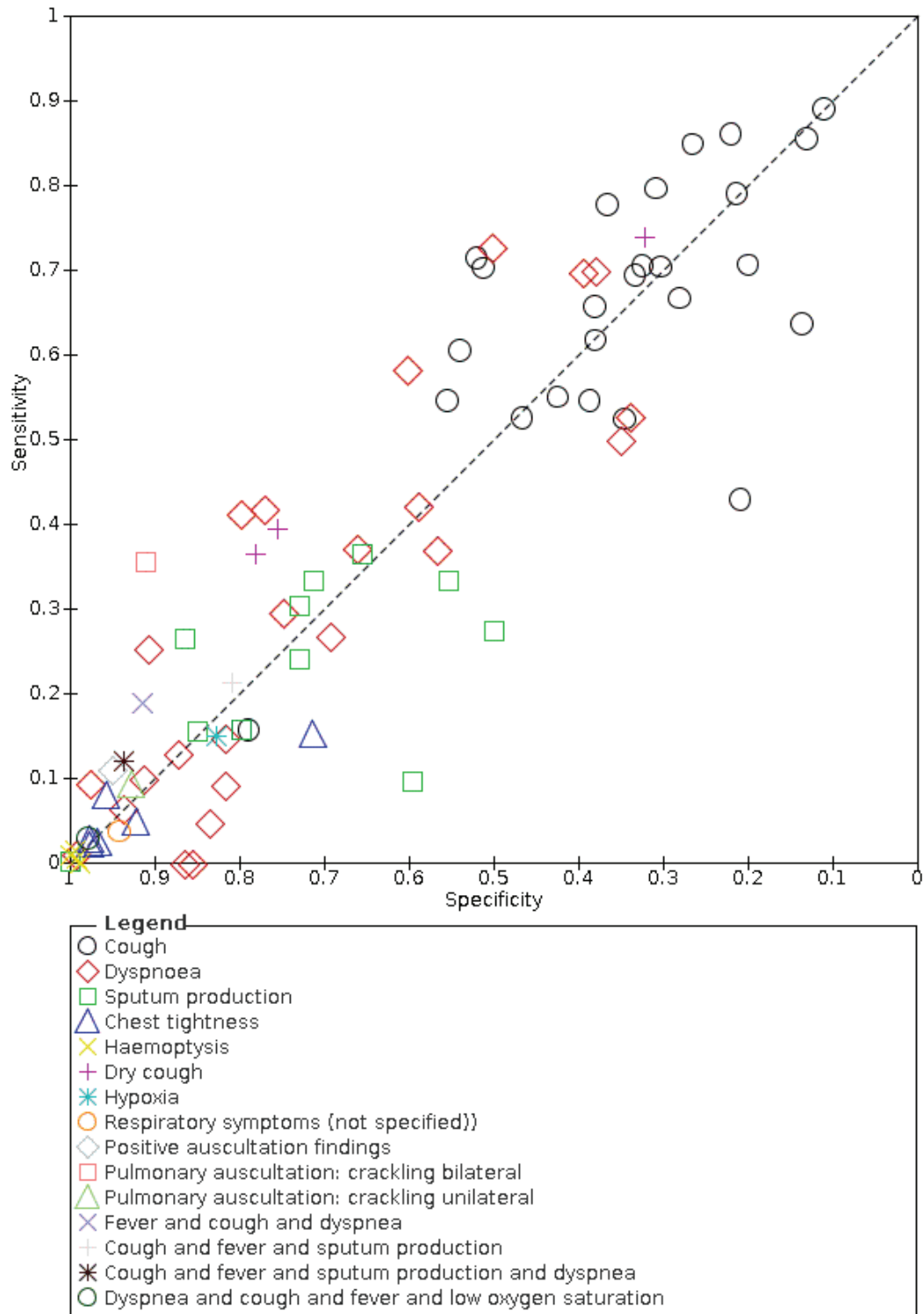


Figure 12. Summary ROC plot of systemic signs and symptoms (cross-sectional studies)

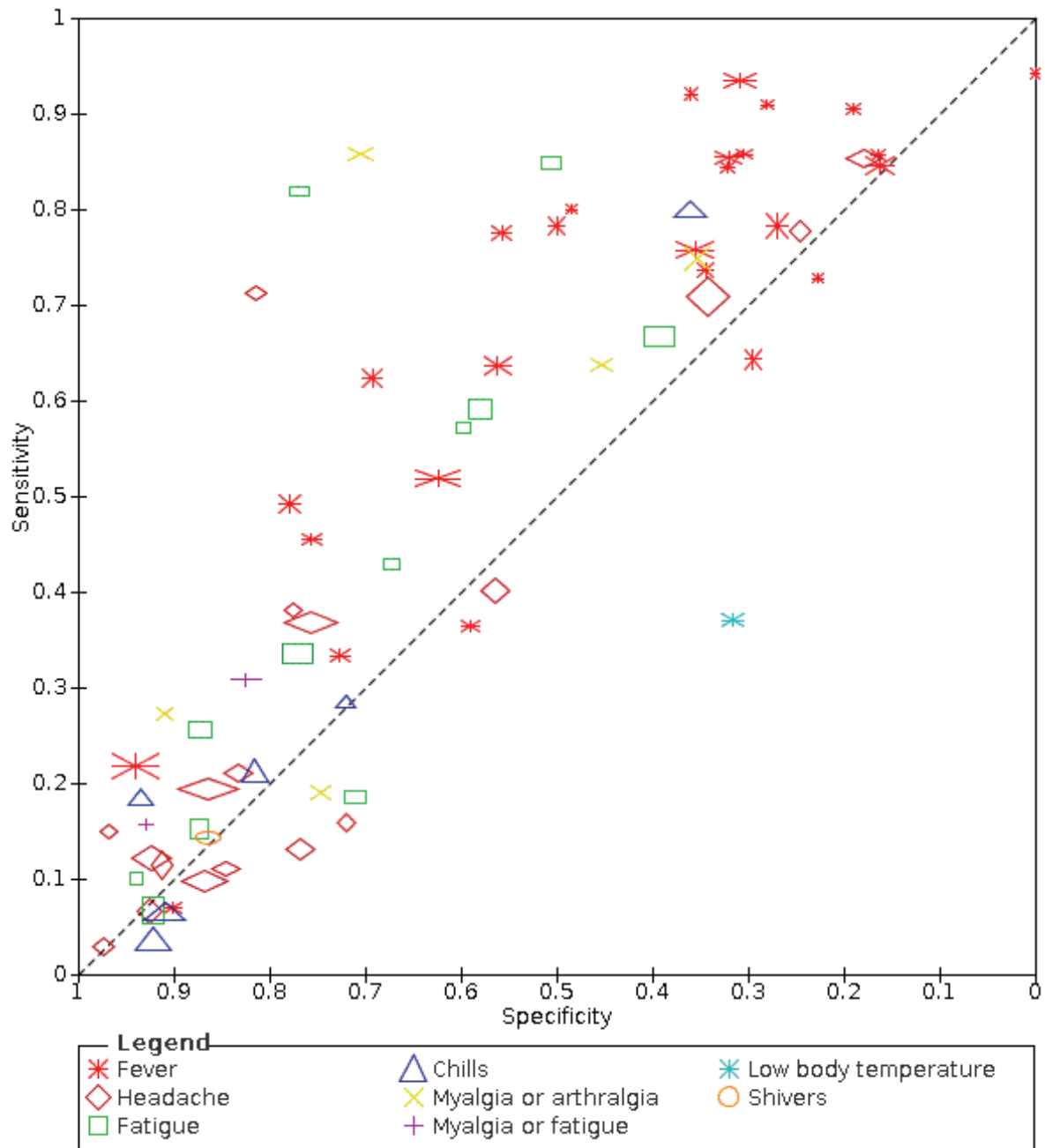


Figure 13. Summary ROC plot of gastrointestinal signs and symptoms (cross-sectional studies)

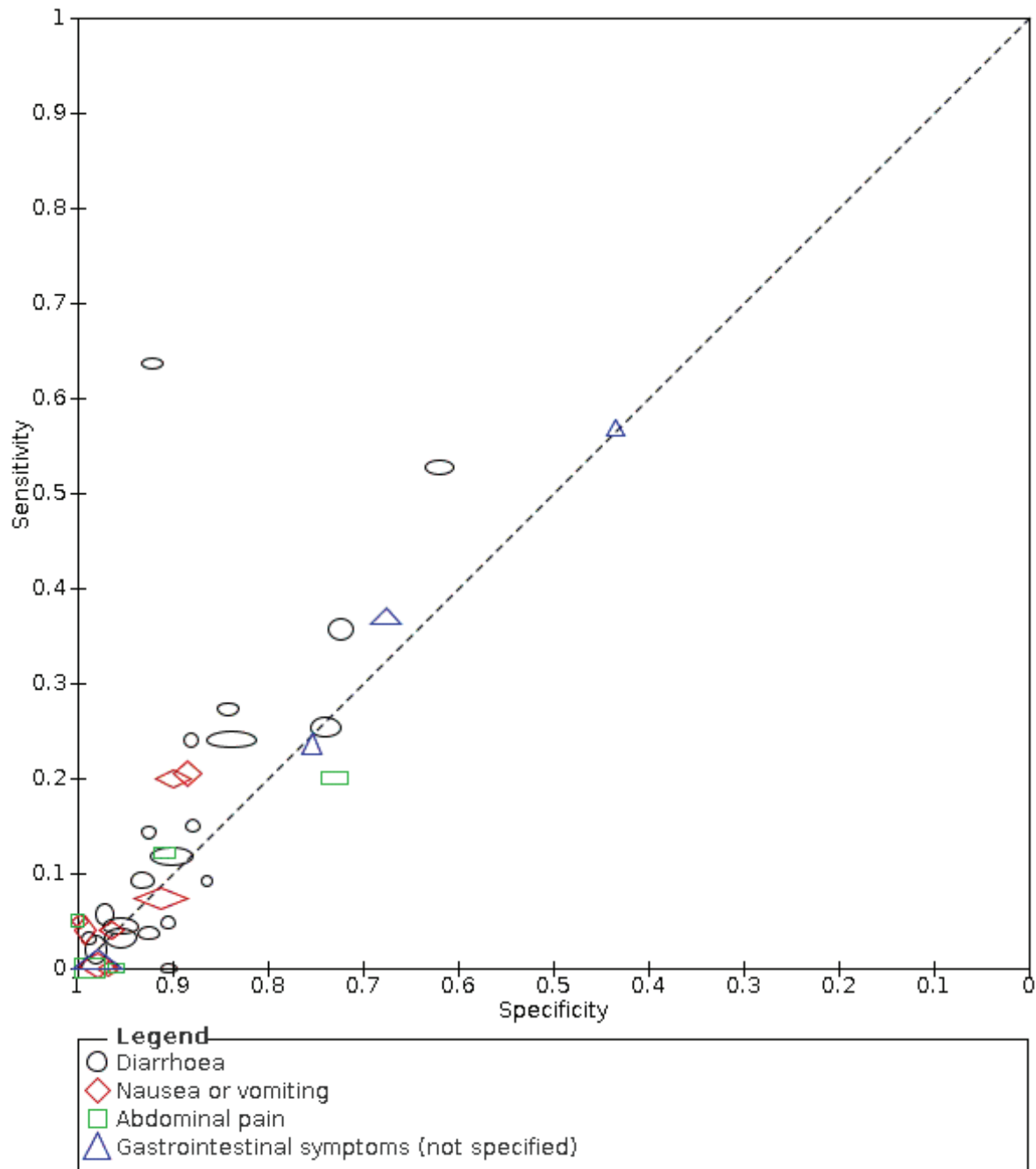


Figure 14. Summary ROC plot of dyspnoea

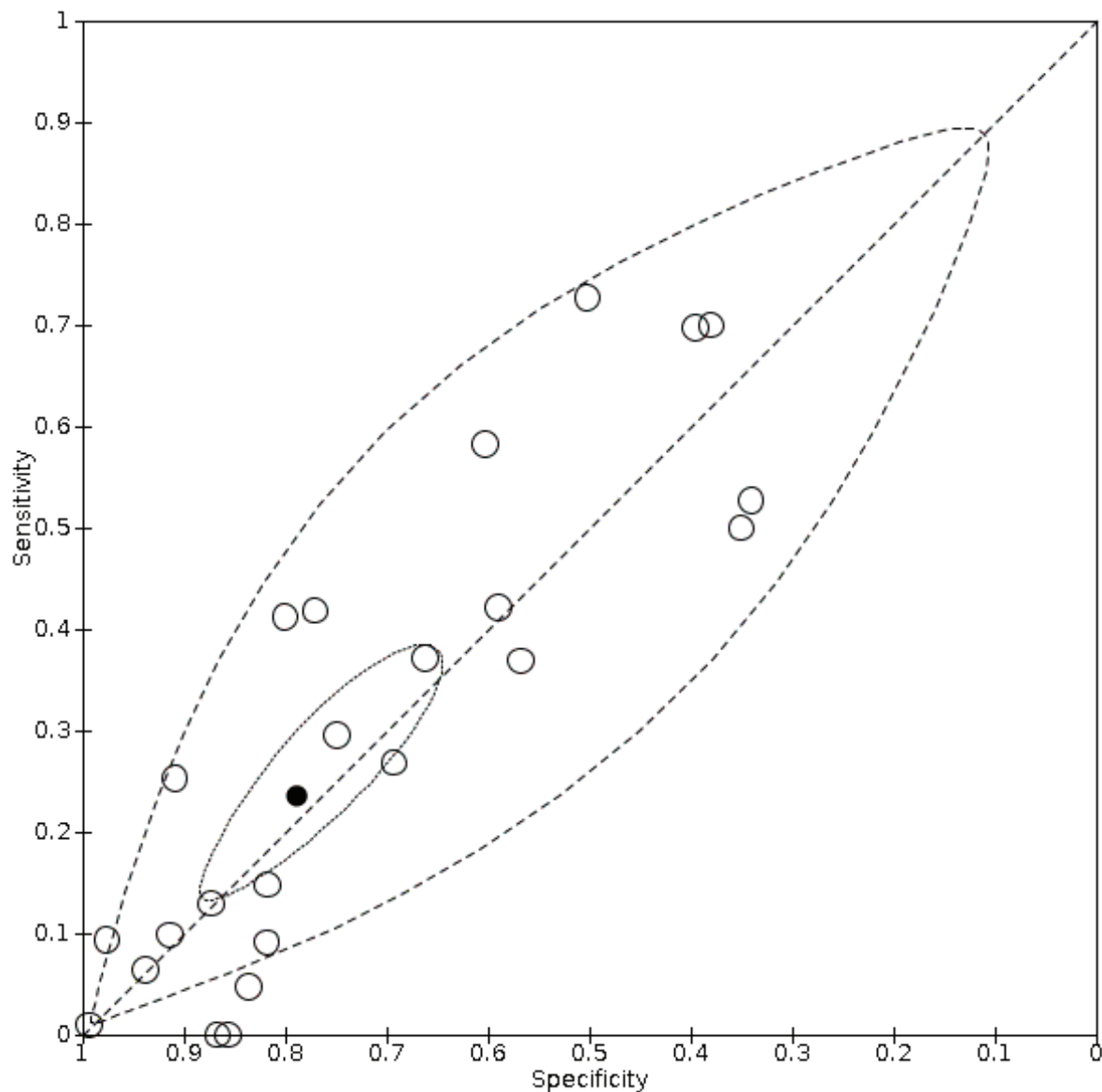


Figure 15. Summary ROC plot of fever. Summary point and 95% confidence region for prospective studies only

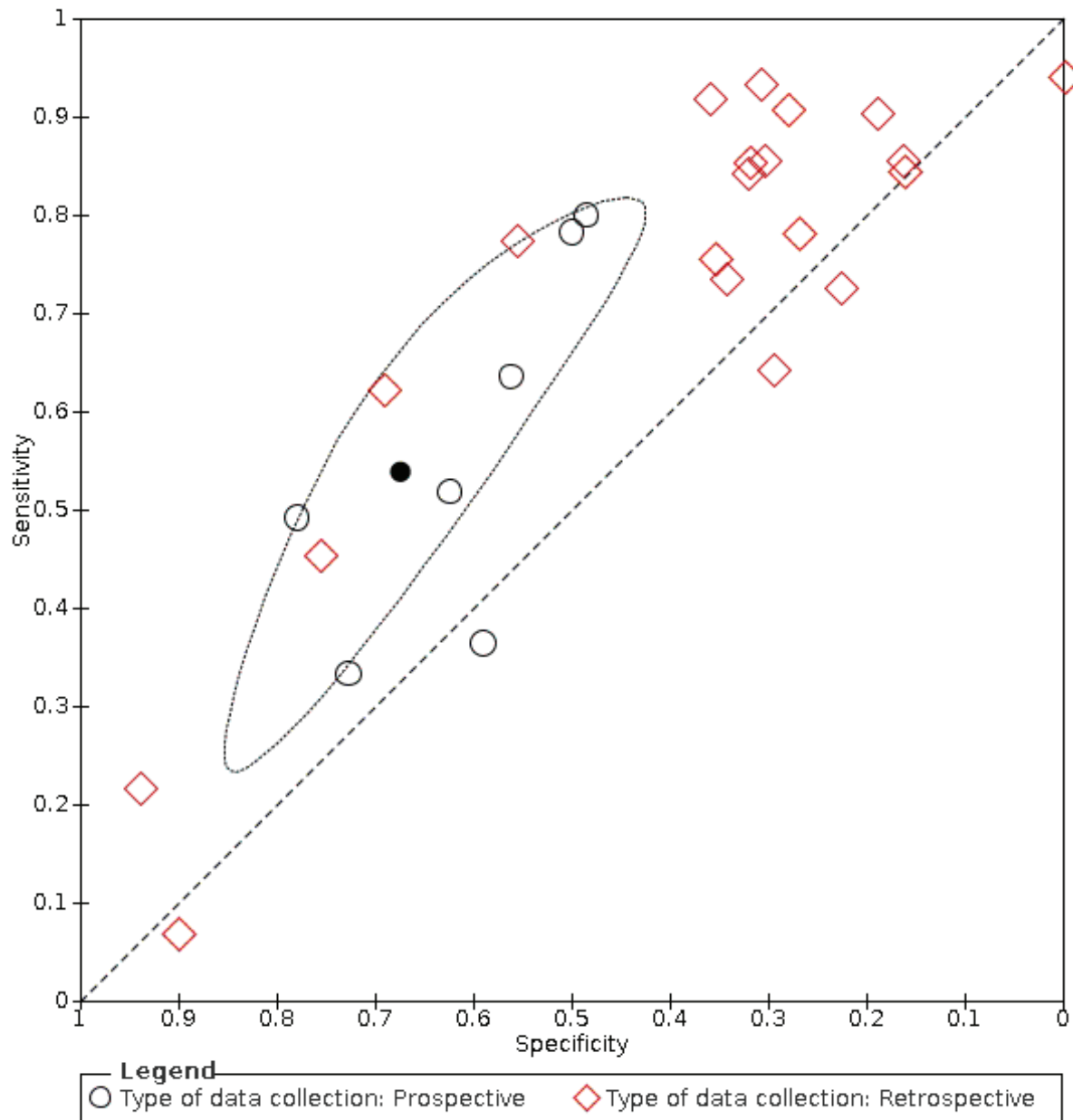


Figure 16. Summary ROC plot of anosmia

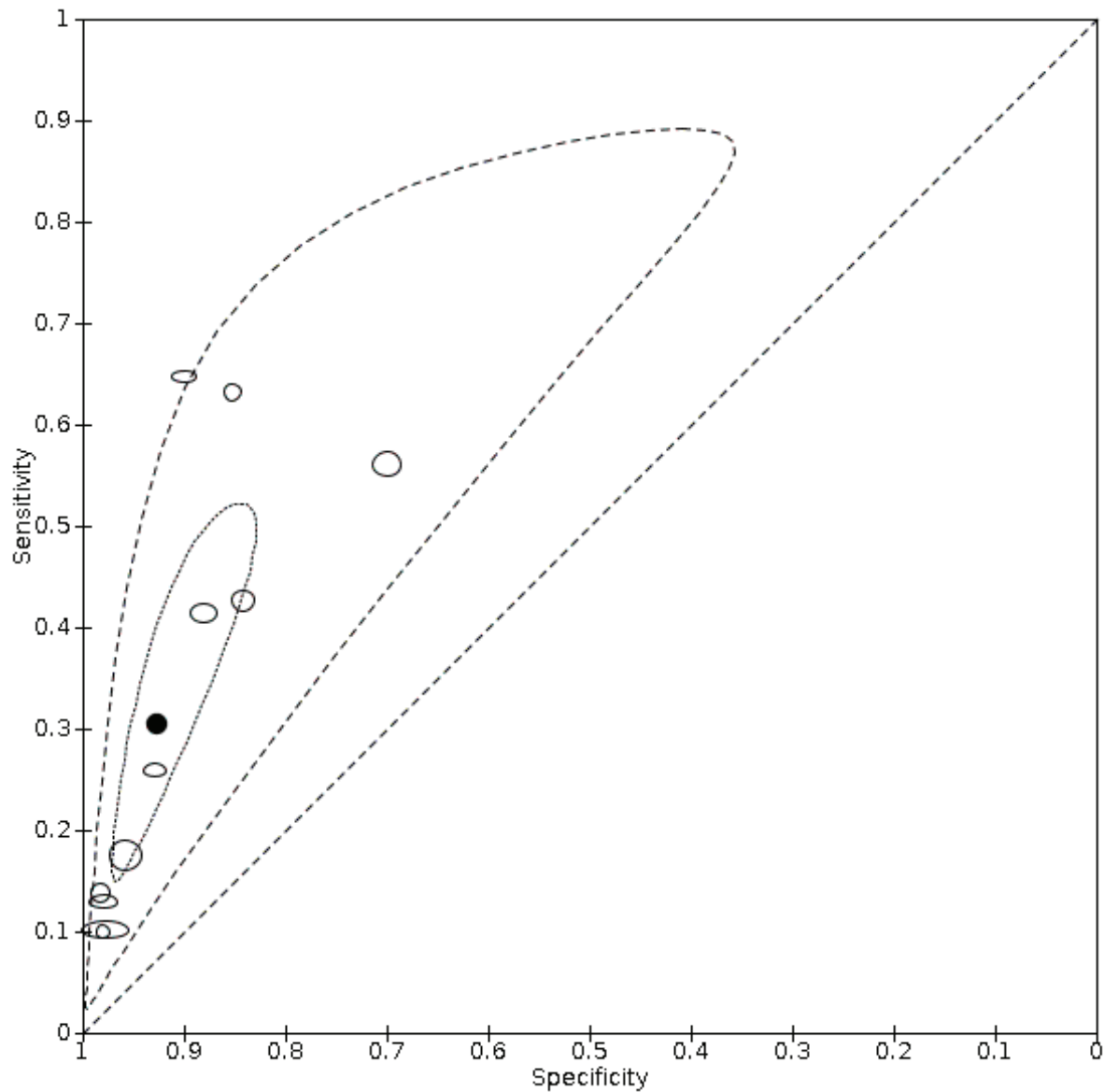


Figure 17. Summary ROC plot of sore throat (cross-sectional studies)

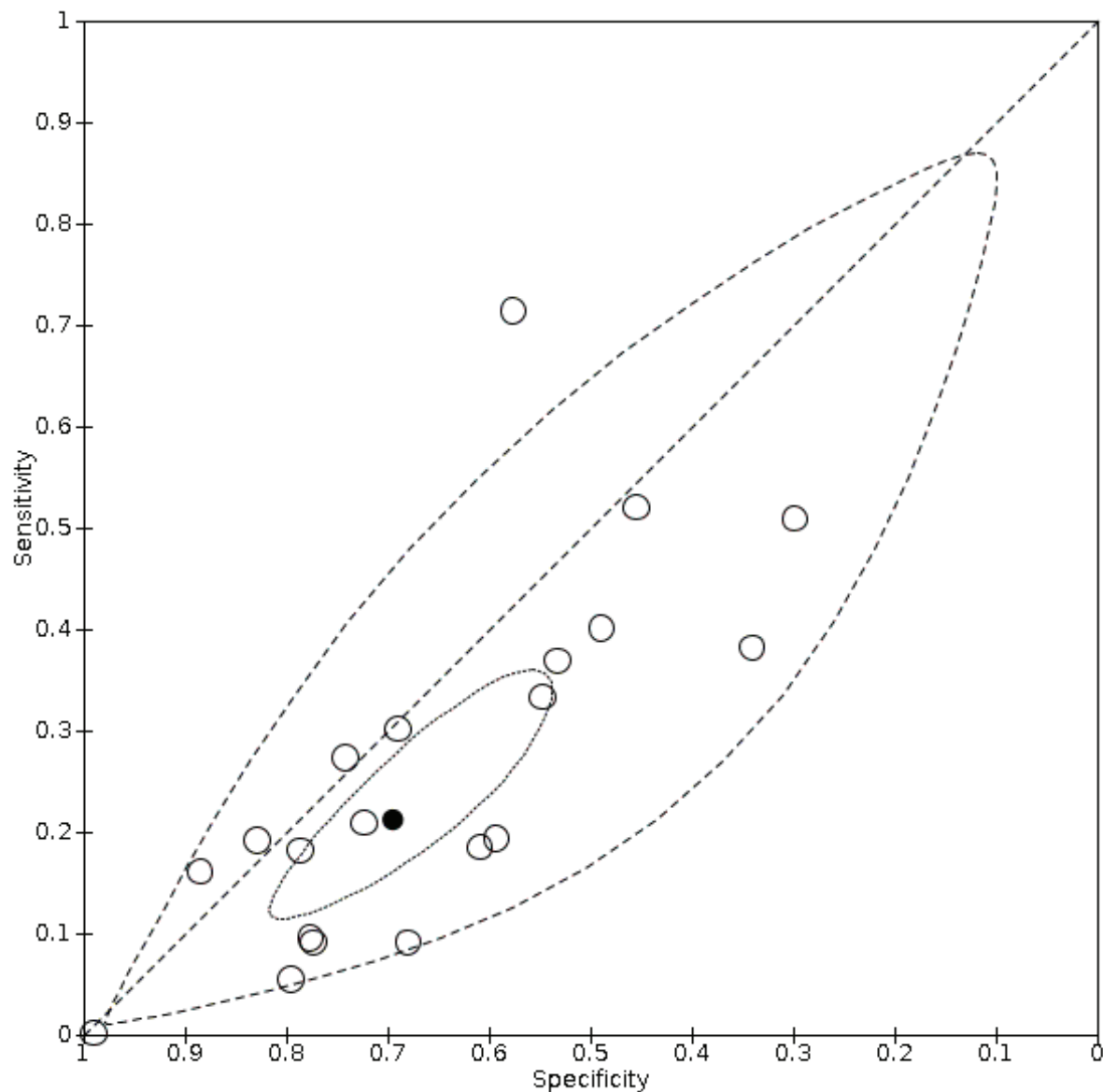


Figure 18. Summary ROC plot of ageusia

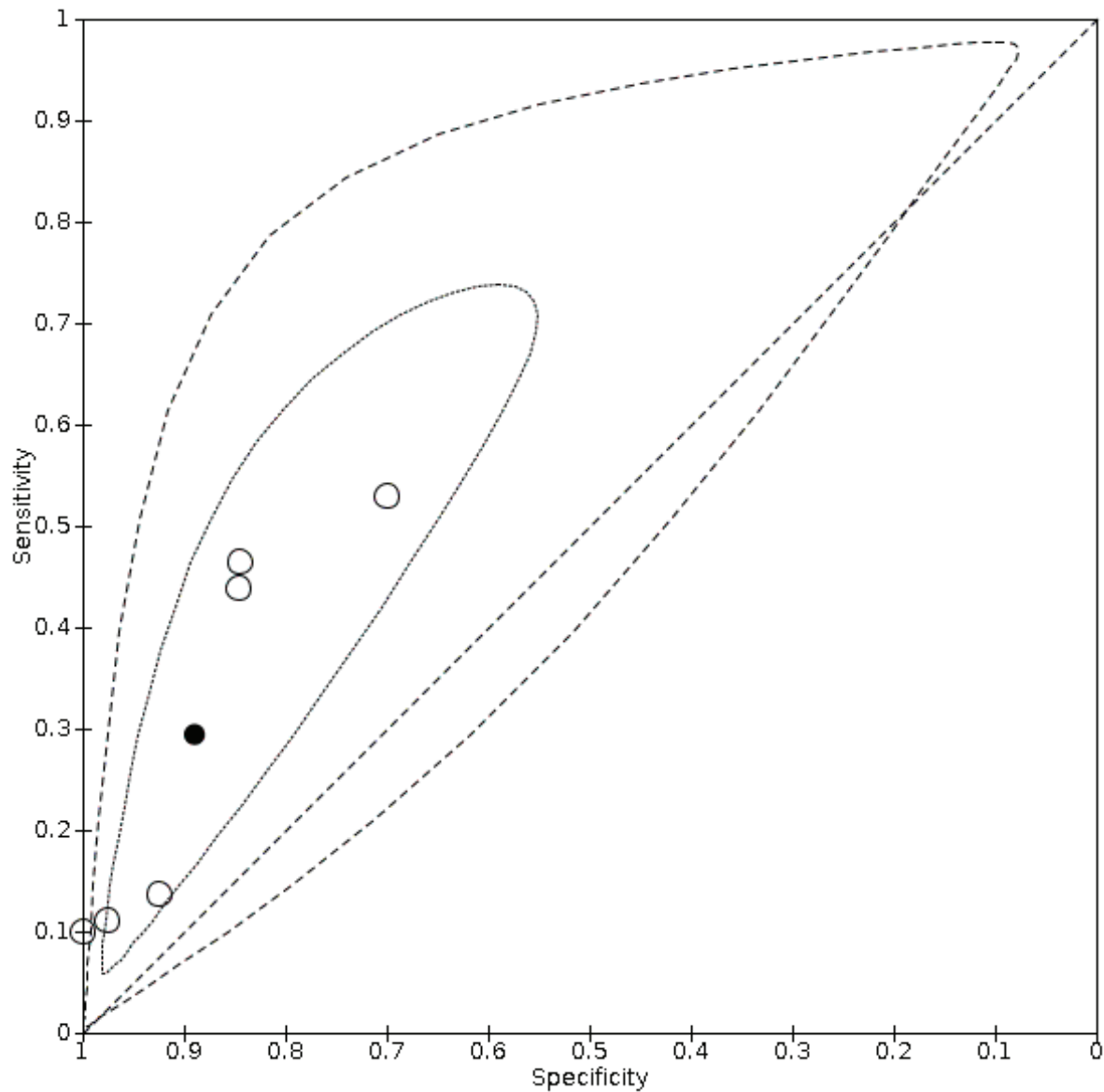


Figure 19. Summary ROC plot of anosmia or ageusia

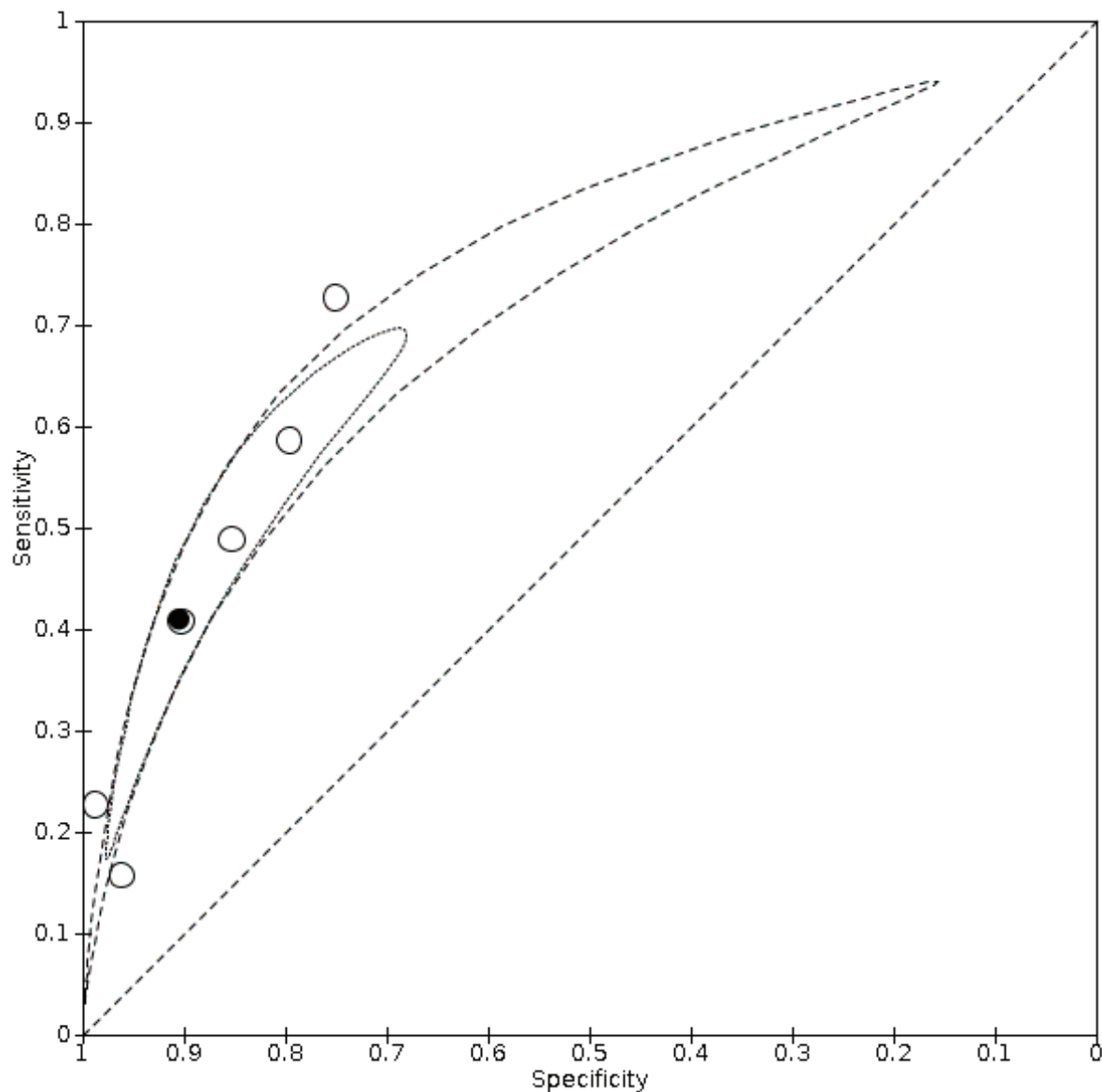


Figure 20. Summary ROC plot of cough (cross-sectional studies)

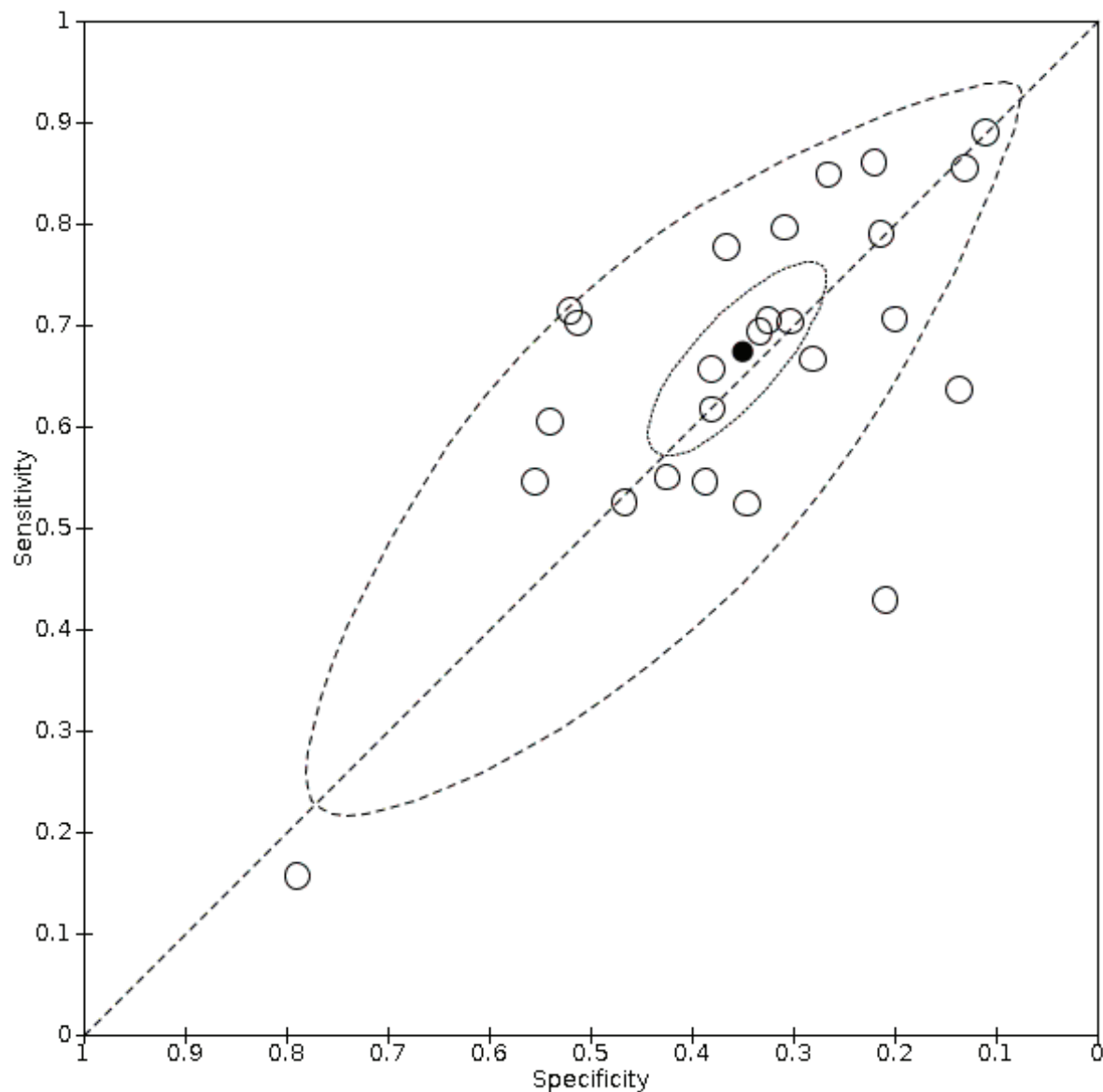


Figure 21. Summary ROC Plot of fatigue

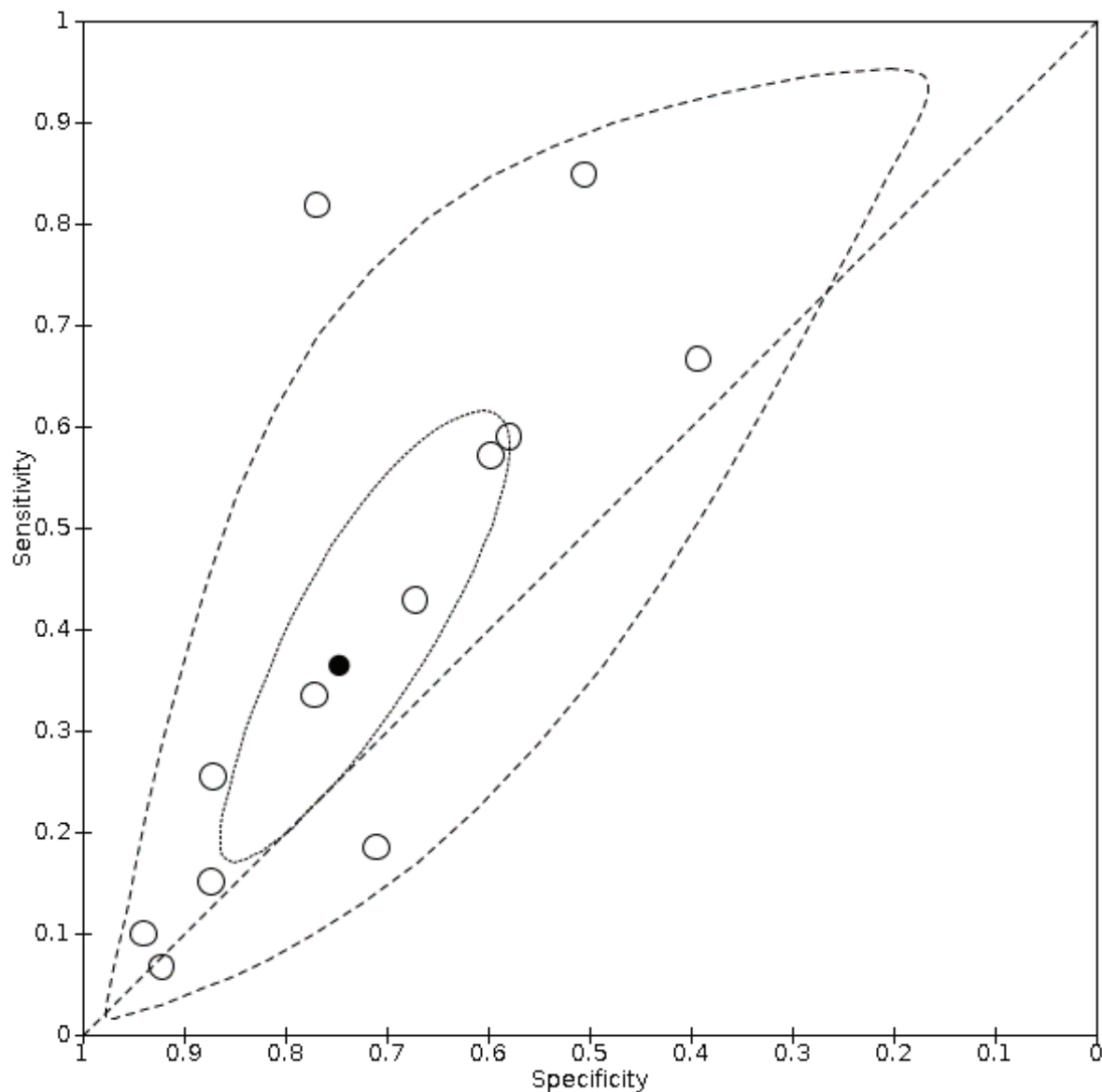


Figure 22. Summary ROC plot of headache. Summary point only estimable in prospective studies

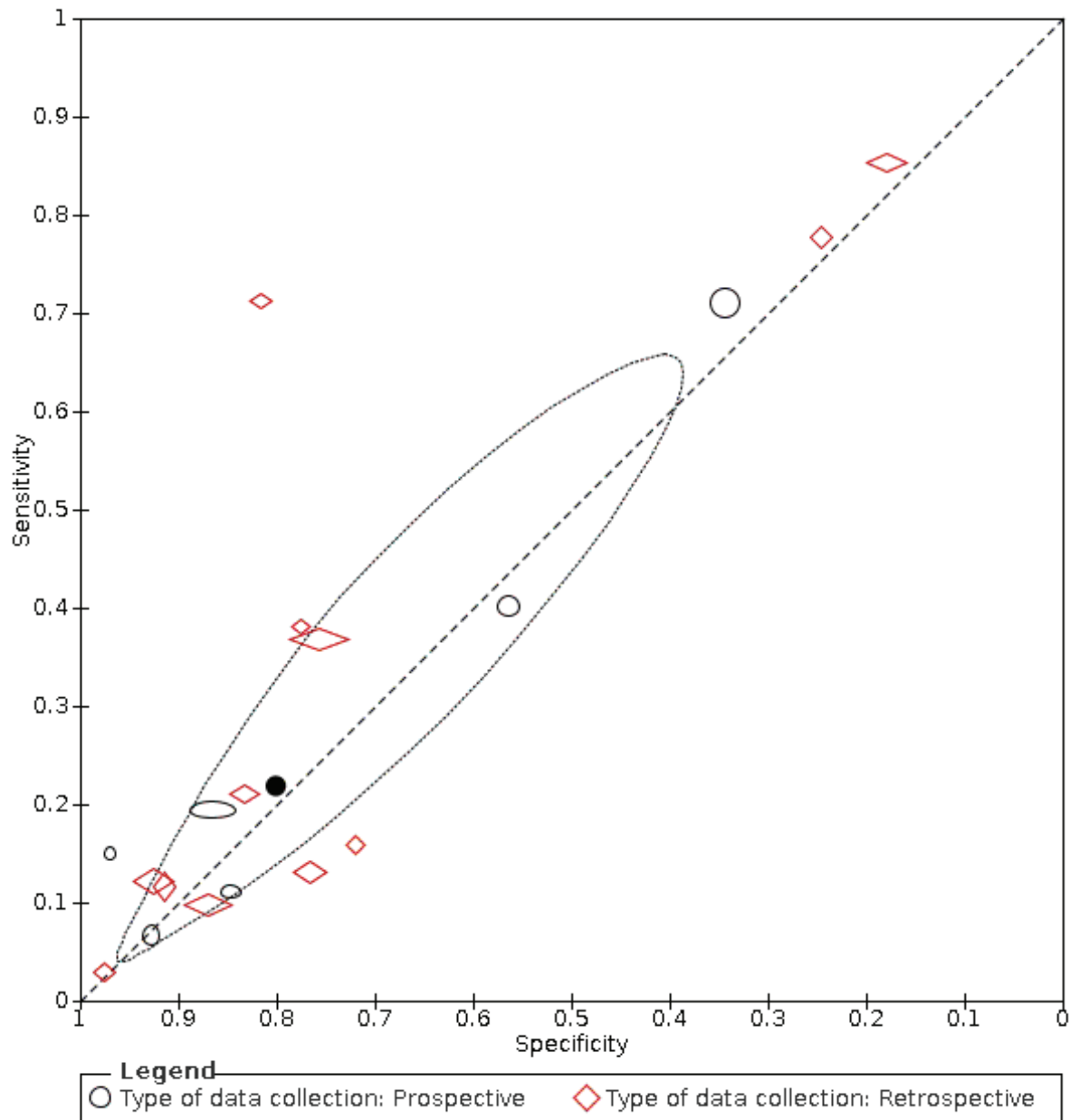


Figure 23. Forest plot of tests: cough (non-cross-sectional study), sore throat (non-cross-sectional study), positive auscultation findings (non-cross-sectional study), rhinorrhoea (non-cross-sectional study), dyspnoea (non-cross-sectional study), sneezing (non-cross-sectional study), nasal congestion (non-cross-sectional study), sputum production (non-cross-sectional study), pulmonary auscultation (crackling) bilateral (non-cross-sectional study),

pulmonary auscultation (crackling unilateral; non-cross-sectional study), pulmonary auscultation (rhonchi; non-cross-sectional study), pulmonary auscultation: sibilant (non-cross-sectional study)

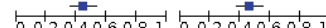
Cough (non-cross-sectional study)

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Lee 2020	37	30	19	41	Prospective	0.66 [0.52, 0.78]	0.58 [0.45, 0.69]		
Zhao 2020	9	12	10	3	Prospective	0.47 [0.24, 0.71]	0.20 [0.04, 0.48]		
Yan 2020	21	104	38	99	Retrospective	0.36 [0.24, 0.49]	0.49 [0.42, 0.56]		
Carignan 2020	97	96	37	38	Retrospective	0.72 [0.64, 0.80]	0.28 [0.21, 0.37]		
Zayet 2020a	56	44	14	10	Retrospective	0.80 [0.69, 0.89]	0.19 [0.09, 0.31]		
Chen 2020	48	56	22	10	Retrospective	0.69 [0.56, 0.79]	0.15 [0.08, 0.26]		
Challenger 2020	42	92	6	6	Retrospective	0.88 [0.75, 0.95]	0.06 [0.02, 0.13]		



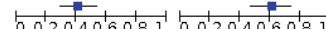
Sore throat (non-cross-sectional study)

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zhao 2020	4	4	15	11	Prospective	0.21 [0.06, 0.46]	0.73 [0.45, 0.92]		
Lee 2020	21	45	35	26	Prospective	0.38 [0.25, 0.51]	0.37 [0.25, 0.49]		
Chen 2020	9	6	61	60	Retrospective	0.13 [0.06, 0.23]	0.91 [0.81, 0.97]		
Yan 2020	10	92	49	111	Retrospective	0.17 [0.08, 0.29]	0.55 [0.48, 0.62]		
Zayet 2020a	14	25	56	30	Retrospective	0.20 [0.11, 0.31]	0.55 [0.41, 0.68]		
Carignan 2020	60	72	74	62	Retrospective	0.45 [0.36, 0.54]	0.46 [0.38, 0.55]		



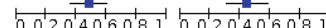
Positive auscultation findings (non-cross-sectional study)

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zhao 2020	2	5	17	10	Prospective	0.11 [0.01, 0.33]	0.67 [0.38, 0.88]		
Zayet 2020b	23	23	72	99	Retrospective	0.24 [0.16, 0.34]	0.81 [0.73, 0.88]		
Zayet 2020a	29	21	41	33	Retrospective	0.41 [0.30, 0.54]	0.61 [0.47, 0.74]		



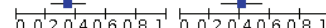
Rhinorrhoea (non-cross-sectional study)

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Lee 2020	15	31	41	40	Prospective	0.27 [0.16, 0.40]	0.56 [0.44, 0.68]		
Chen 2020	3	3	67	63	Retrospective	0.04 [0.01, 0.12]	0.95 [0.87, 0.99]		
Yan 2020	6	40	53	163	Retrospective	0.10 [0.04, 0.21]	0.80 [0.74, 0.86]		
Carignan 2020	60	73	74	61	Retrospective	0.45 [0.36, 0.54]	0.46 [0.37, 0.54]		
Zayet 2020a	34	30	36	24	Retrospective	0.49 [0.36, 0.61]	0.44 [0.31, 0.59]		



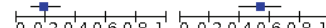
Dyspnoea (non-cross-sectional study)

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Lee 2020	21	19	35	52	Prospective	0.38 [0.25, 0.51]	0.73 [0.61, 0.83]		
Yan 2020	7	47	52	156	Retrospective	0.12 [0.05, 0.23]	0.77 [0.70, 0.82]		
Carignan 2020	56	49	78	85	Retrospective	0.42 [0.33, 0.51]	0.63 [0.55, 0.72]		
Zayet 2020a	24	32	46	22	Retrospective	0.34 [0.23, 0.47]	0.41 [0.28, 0.55]		



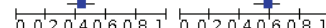
Sneezing (non-cross-sectional study)

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Carignan 2020	53	58	81	76	Retrospective	0.40 [0.31, 0.48]	0.57 [0.48, 0.65]		
Zayet 2020a	13	25	57	29	Retrospective	0.19 [0.10, 0.30]	0.54 [0.40, 0.67]		



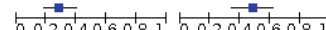
Nasal congestion (non-cross-sectional study)

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Lee 2020	23	27	33	44	Prospective	0.41 [0.28, 0.55]	0.62 [0.50, 0.73]		
Chen 2020	2	4	68	62	Retrospective	0.03 [0.00, 0.10]	0.94 [0.85, 0.98]		
Yan 2020	11	43	48	160	Retrospective	0.19 [0.10, 0.31]	0.79 [0.73, 0.84]		
Zayet 2020a	13	19	57	35	Retrospective	0.19 [0.10, 0.30]	0.65 [0.51, 0.77]		
Carignan 2020	58	56	76	78	Retrospective	0.43 [0.35, 0.52]	0.58 [0.49, 0.67]		



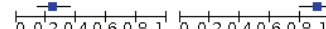
Sputum production (non-cross-sectional study)

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Carignan 2020	40	43	94	91	Retrospective	0.30 [0.22, 0.38]	0.68 [0.59, 0.76]		
Zayet 2020a	20	28	50	26	Retrospective	0.29 [0.18, 0.41]	0.48 [0.34, 0.62]		



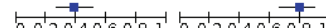
Pulmonary auscultation: crackling bilateral (non-cross-sectional study)

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zayet 2020a	17	5	53	49	Retrospective	0.24 [0.15, 0.36]	0.91 [0.80, 0.97]		



Pulmonary auscultation: crackling unilateral (non-cross-sectional study)

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zayet 2020a	27	11	43	43	Retrospective	0.39 [0.27, 0.51]	0.80 [0.66, 0.89]		



Pulmonary auscultation: rhonchi (non-cross-sectional study)

Figure 23. (Continued)

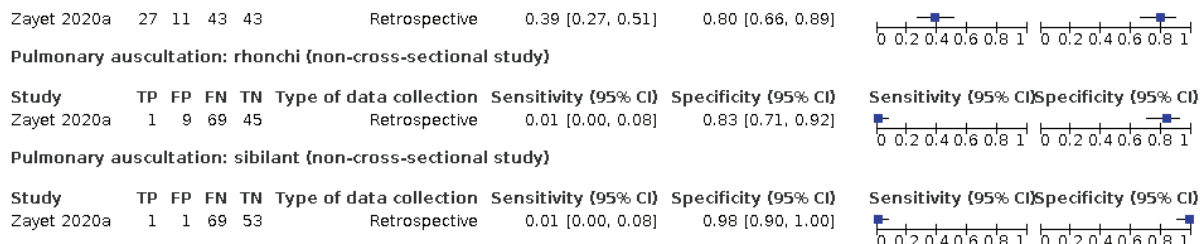


Figure 24. Forest plot of tests: fever (non-cross-sectional study), fatigue (non-cross-sectional study), myalgia or arthralgia (non-cross-sectional study), headache (non-cross-sectional study), asthenia (non-cross-sectional study), fever (subjective, non-cross-sectional study), arthralgia (non-cross-sectional study)

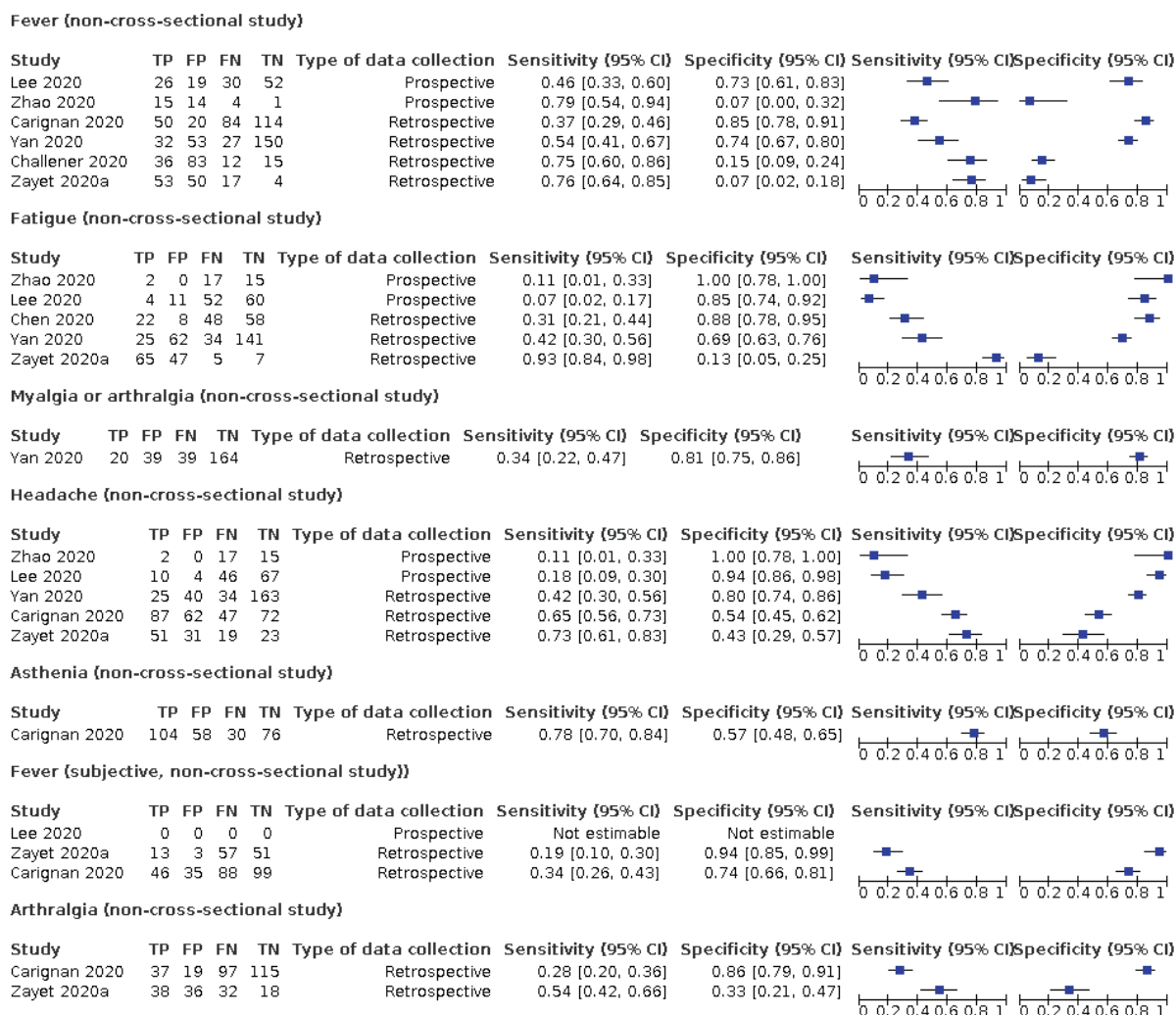


Figure 25. Forest plot of tests: diarrhoea (non-cross-sectional study), nausea/vomiting (non-cross-sectional study), gastrointestinal symptoms (not specified; non-cross-sectional study), nausea (non-cross-sectional study), vomiting (non-cross-sectional study), abdominal pain (non-cross-sectional study)

Diarrhoea (non-cross-sectional study)

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zhao 2020	1	1	18	14	Prospective	0.05 [0.00, 0.26]	0.93 [0.68, 1.00]		
Lee 2020	20	13	36	58	Prospective	0.36 [0.23, 0.50]	0.82 [0.71, 0.90]		
Yan 2020	5	16	54	187	Retrospective	0.08 [0.03, 0.19]	0.92 [0.88, 0.95]		
Nobel 2020	56	36	222	202	Retrospective	0.20 [0.16, 0.25]	0.85 [0.80, 0.89]		
Zayet 2020a	28	11	42	43	Retrospective	0.40 [0.28, 0.52]	0.80 [0.66, 0.89]		
Carignan 2020	60	31	74	103	Retrospective	0.45 [0.36, 0.54]	0.77 [0.69, 0.84]		

Nausea/vomiting (non-cross-sectional study)

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Nobel 2020	63	46	215	192	Retrospective	0.23 [0.18, 0.28]	0.81 [0.75, 0.85]		

Gastrointestinal symptoms, not specified (non-cross-sectional study)

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Nobel 2020	97	63	181	175	Retrospective	0.35 [0.29, 0.41]	0.74 [0.67, 0.79]		

Nausea (non-cross-sectional study)

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Yan 2020	3	8	56	195	Retrospective	0.05 [0.01, 0.14]	0.96 [0.92, 0.98]		
Carignan 2020	40	17	94	117	Retrospective	0.30 [0.22, 0.38]	0.87 [0.80, 0.92]		
Zayet 2020a	22	11	48	43	Retrospective	0.31 [0.21, 0.44]	0.80 [0.66, 0.89]		

Vomiting (non-cross-sectional study)

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Carignan 2020	9	5	125	129	Retrospective	0.07 [0.03, 0.12]	0.96 [0.92, 0.99]		
Zayet 2020a	2	12	68	42	Retrospective	0.03 [0.00, 0.10]	0.78 [0.64, 0.88]		

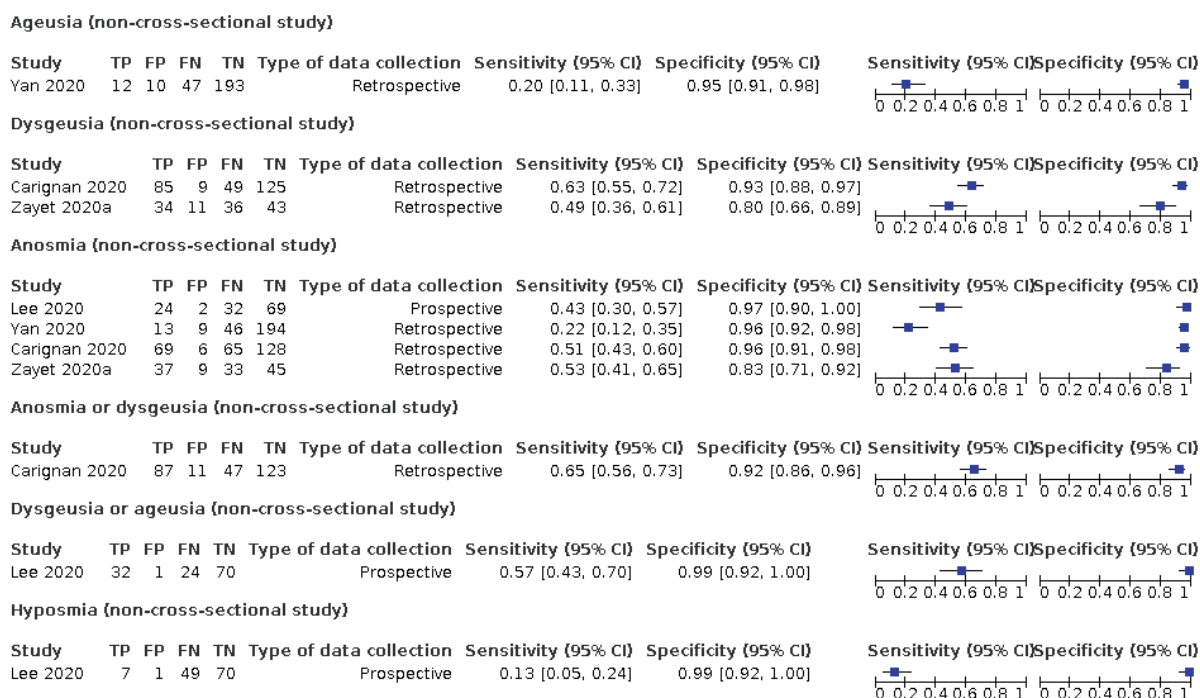
Abdominal pain (non-cross-sectional study)

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Lee 2020	7	6	49	65	Prospective	0.13 [0.05, 0.24]	0.92 [0.83, 0.97]		
Zayet 2020a	14	9	56	45	Retrospective	0.20 [0.11, 0.31]	0.83 [0.71, 0.92]		

Figure 26. Forest plot of chest tightness (non-cross-sectional study)

Study	TP	FP	FN	TN	Type of data collection	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zhao 2020	1	0	18	15	Prospective	0.05 [0.00, 0.26]	1.00 [0.78, 1.00]		
Zayet 2020a	18	10	52	44	Retrospective	0.26 [0.16, 0.38]	0.81 [0.69, 0.91]		
Carignan 2020	35	30	99	104	Retrospective	0.26 [0.19, 0.34]	0.78 [0.70, 0.84]		

Figure 27. Forest plot of tests: ageusia (non-cross-sectional study), dysgeusia (non-cross-sectional study), anosmia (non-cross-sectional study), anosmia or dysgeusia (non-cross-sectional study), dysgeusia or ageusia (non-cross-sectional study), hyposmia (non-cross-sectional study)



Only two studies (Gilbert 2020; Yombi 2020), assessed combinations of different signs and symptoms. Gilbert 2020 investigated six combinations of two to four symptoms and signs each, while Yombi 2020 investigated three combinations of two to three symptoms each. Most of the combinations included fever and cough, on which both studies had preselected their participants. These combinations led to specificities above 80%, but at the cost of low sensitivities (< 30%).

Positivity rates of symptoms and signs depend on prevalence and population characteristics, especially pre-selection. As a result, positivity rates were highly variable. In studies with prevalence less than 5%, suggesting little pre-selection had taken place, positivity rates for fever (presence of the symptom in the study population) were between 9% and 41% (11.7% average), for cough between 45% and 70% (68% average), for anosmia between 2.5% and 2.6% (2.5% average), for ageusia (1 study) 2.8%, and for anosmia or ageusia (1 study) 4.3%.

Signs and symptoms for which sensitivity was reported above 50% in at least one cross-sectional study are summarised below.

Symptoms and signs for which we performed pooling

We were able to conduct meta-analyses for 14 signs or symptoms (cough, fever, anosmia, ageusia, anosmia or ageusia, sore throat, myalgia, fatigue, headache, dyspnoea, diarrhoea, sputum production, nausea or vomiting, chest tightness) based on clinically acceptable heterogeneity, the scatter of studies on visual inspection of the forest plots, and for which at least five studies

were available. The analyses were restricted to cross-sectional studies only. The ranges and summary estimates of the sensitivity and specificity of the 14 index tests are listed below. Additional summary point statistics are listed in additional Table 4.

Cough

- Sensitivity ranged from 16% to 89%; specificity from 11% to 79%
- Pooled sensitivity 67.4% (95% confidence interval (CI) 59.8% to 74.1%); pooled specificity 35.0% (95% CI 28.7% to 41.9%); 25 studies, 15,459 participants

Anosmia

- Sensitivity ranged from 10% to 65%; specificity from 70% to 98%
- Pooled sensitivity 28.0% (95% CI 17.7% to 41.3%); pooled specificity 93.4% (95% CI 88.3% to 96.4%); 11 studies, 9552 participants

Ageusia

- Sensitivity ranged from 10% to 55%; specificity from 70% to 100%
- Pooled sensitivity 24.8% (95% CI 12.4% to 43.5%) pooled specificity 91.4% (95% CI 81.3% to 96.3%); 6 studies, 7393 participants

Anosmia or ageusia

- Sensitivity ranged from 16% to 73%; specificity from 75% to 99%

- Pooled sensitivity 41.0% (95% CI 27.0% to 56.6%); pooled specificity 90.5% (95% CI 81.2% to 95.4%); 6 studies, 8142 participants

Sore throat

- Sensitivity ranged from 0% to 71%; specificity from 30% to 99%
- Pooled sensitivity 21.2% (95% CI 13.5% to 31.6%); pooled specificity 69.5% (95% CI 58.1% to 78.9%); 20 studies, 15,876 participants

Myalgia

- Sensitivity ranged from 1% to 65%; specificity from 33% to 99%
- Pooled sensitivity 26.6% (95% CI 15.3% to 42.2%); pooled specificity 83.1% (95% CI 70.6% to 90.9%); 13 studies, 8105 participants

Fatigue

- Sensitivity ranged from 7% to 85%; specificity from 39% to 94%
- Pooled sensitivity 36.4% (95% CI 22.1% to 53.6%); pooled specificity 74.7% (95% CI 63.6% to 83.3%); 12 studies, 5653 participants

Dyspnoea

- Sensitivity ranged from 0% to 73%; specificity from 34% to 99%
- Pooled sensitivity 24.9% (95% CI 16.6% to 35.5%); pooled specificity 77.1% (95% CI 66.8% to 84.8%); 24 studies, 14,913 participants

Diarrhoea

- Sensitivity ranged from 0% to 64%; specificity from 62% to 99%
- Pooled sensitivity 11.6% (95% CI 7.6% to 17.4%); pooled specificity 90.6% (95% CI 86.6% to 93.5%); 20 studies, 13,016 participants

Sputum production

- Sensitivity ranged from 0% to 36%; specificity from 50% to 100%
- Pooled sensitivity 18.9% (95% CI 8.1% to 38.1%); pooled specificity 81.3% (95% CI 57.9% to 93.2%); 10 studies, 5144 participants

Nausea or vomiting

- Sensitivity ranged from 0% to 20%; specificity from 88% to 100%
- Pooled sensitivity 5.4% (95% CI 2.4% to 11.5%); pooled specificity 95.3% (95% CI 92.0% to 97.3%); 8 studies, 5381 participants

Chest tightness

- Sensitivity ranged from 2% to 15%; specificity from 71% to 98%
- Pooled sensitivity 4.7% (95% CI 2.5% to 8.9%); pooled specificity 94.6% (95% CI 88.6% to 97.6%); 6 studies, 6057 participants

We performed sensitivity analyses to investigate the impact of prospective versus retrospective data collection:

Fever

- Sensitivity analysis (prospective data collection only): sensitivity ranged from 7% to 94%; specificity from 0% to 94%

- Pooled sensitivity 53.8% (95% CI 35.0% to 71.7%); pooled specificity 67.4% (95% CI 53.3% to 78.9%); 7 studies, 5548 participants

Headache

- Sensitivity analysis (prospective data collection only): sensitivity ranged from 3% to 85%; specificity from 18% to 98%
- Pooled sensitivity 21.9% (95% CI 9.2% to 43.5%); pooled specificity 80.1% (95% CI 60.2% to 91.4%); 6 studies, 6171 participants

Cough and fever (see sensitivity analyses) were the only index tests with a pooled sensitivity above 50% but their pooled specificity was only 35.5% and 67.4% respectively (Figure 20; Figure 15). Pooled specificity was above 90% for diarrhoea, nausea or vomiting, chest tightness, anosmia, ageusia, and for the presence of anosmia or ageusia (Figure 16; Figure 19). However, their pooled sensitivity was very low (maximum 11.6% for diarrhoea), except for anosmia (28.0%) and anosmia or ageusia (41.0%).

The only tests exceeding a pooled diagnostic odds ratio (DOR) of 5 were anosmia as a single test or in combination with ageusia (anosmia or ageusia). Yet, their pooled positive likelihood ratio (LR+) was below our predefined cut-off of 5 for a useful red flag (4.25 (95% CI 3.17 to 5.71) and 4.31 (95% CI 3.00 to 6.18), respectively). The pooled negative likelihood ratios (LRs-) were too high to make any of the reported tests useful to rule out the presence of COVID-19 disease. In other words, the absence of the above mentioned index tests does not necessarily imply the absence of COVID-19 disease.

Symptoms and signs for which we did not perform pooling

- Rhinorrhoea (5 studies, 2252 participants): sensitivity between 4% to 62%, specificity between 37% to 93%
- Chills (6 studies, 4151 participants): sensitivity between 4% to 80%, specificity between 36% to 93%
- Myalgia or arthralgia (5 studies, 556 participants): sensitivity between 19% to 86%, specificity between 35% to 91%
- Anosmia or dysgeusia (2 studies, 457 participants): sensitivity between 9% to 74%, specificity between 78% to 97%

Sensitivity analyses

In sensitivity analyses, we excluded studies that did not use a prospective study design (20 out of 32 cross-sectional studies excluded). The results show that the pooled diagnostic accuracy estimates were not substantially different from the overall result (Table 4). In these sensitivity analyses, the scatter of studies on visual inspection of the forest plots appeared to decrease for fever and we decided to add a meta-analysis for fever using prospective studies only. The pooled sensitivity and specificity of fever in prospective studies was 53.8% and 67.4% respectively Figure 15. This is the highest observed combination of both sensitivity and specificity for a symptom or sign, but the LR+ is still only 1.65 (95% CI 1.41 to 1.93).

To further illustrate a test's ability to either rule in or rule out COVID-19, we constructed dumbbell plots showing pre- and post-test probabilities for each olfactory symptom, fever and cough in each cross-sectional study (Figure 28; Figure 29; Figure 30). For each test, we have plotted the pre-test probability, which is the prevalence of COVID-19 in the study (blue dot). The probability of having COVID-19 after testing (post-test probability) then changes

depending on a positive test result (red dot marked +) or a negative test result (green dot marked -). The plot shows that the presence of anosmia, for example, increases the probability of COVID-19 in all 11 studies. Its absence clearly decreases the probability of COVID-19

in four studies (Brotans 2020; Leal 2020; Tudrej 2020; Zayet 2020b), and in the seven other studies there is not much difference between pre- and post-test probability (Chua 2020; Haehner 2020; Just 2020; Peyrony 2020; Salmon 2020; Tordjman 2020; Trubiano 2020).

Figure 28. Dumbbell plot: olfactory symptoms (cross-sectional studies only). This plot shows how disease probability changes after a positive test result (red dot with plus sign) or after a negative test (green dot with minus sign). Pre-test probability or prevalence is the blue dot

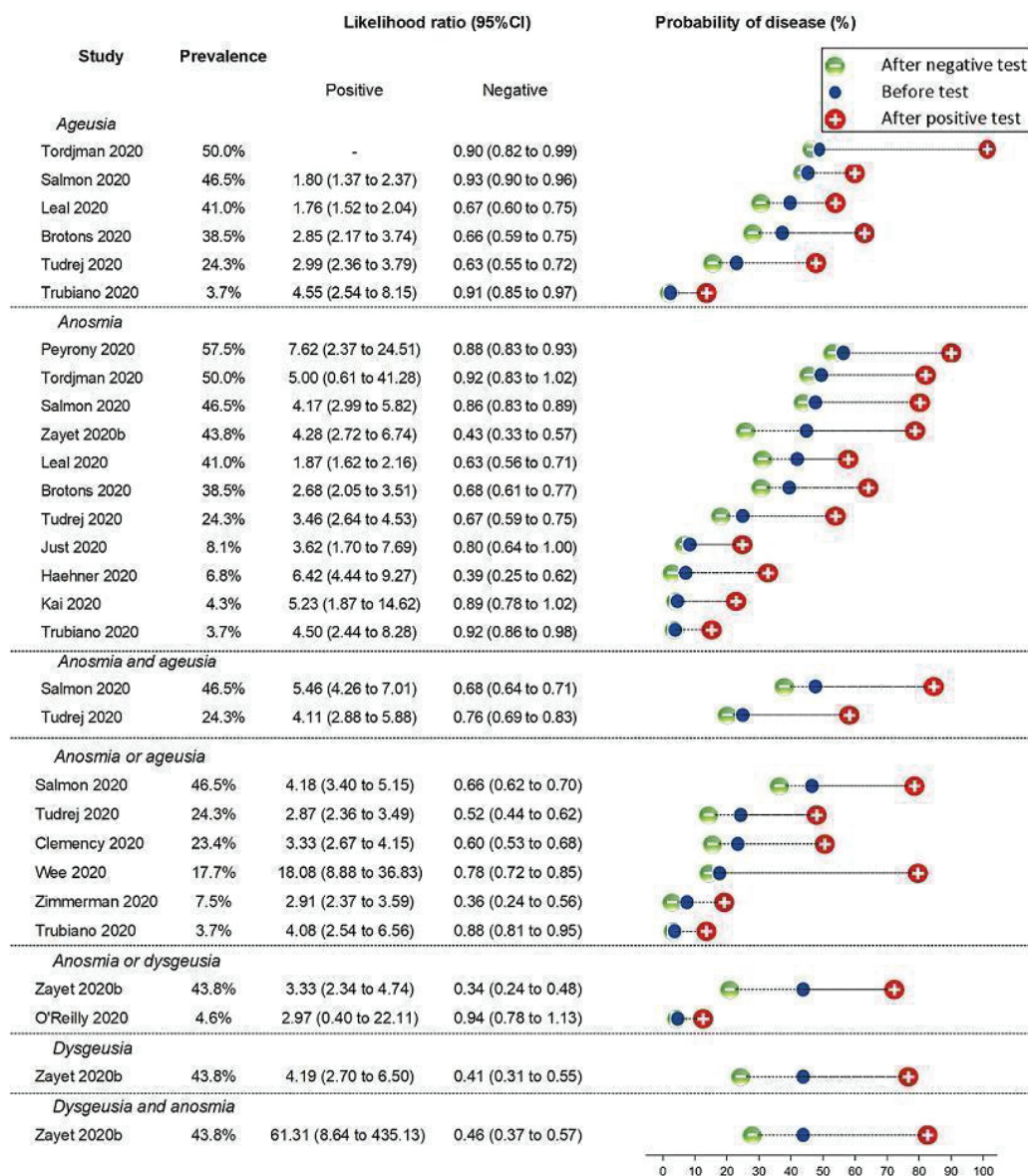


Figure 29. Dumbbell plot: fever. This plot shows how disease probability changes after a positive test result (red dot with plus sign) or after a negative test (green dot with minus sign). Pre-test probability or prevalence is the blue dot

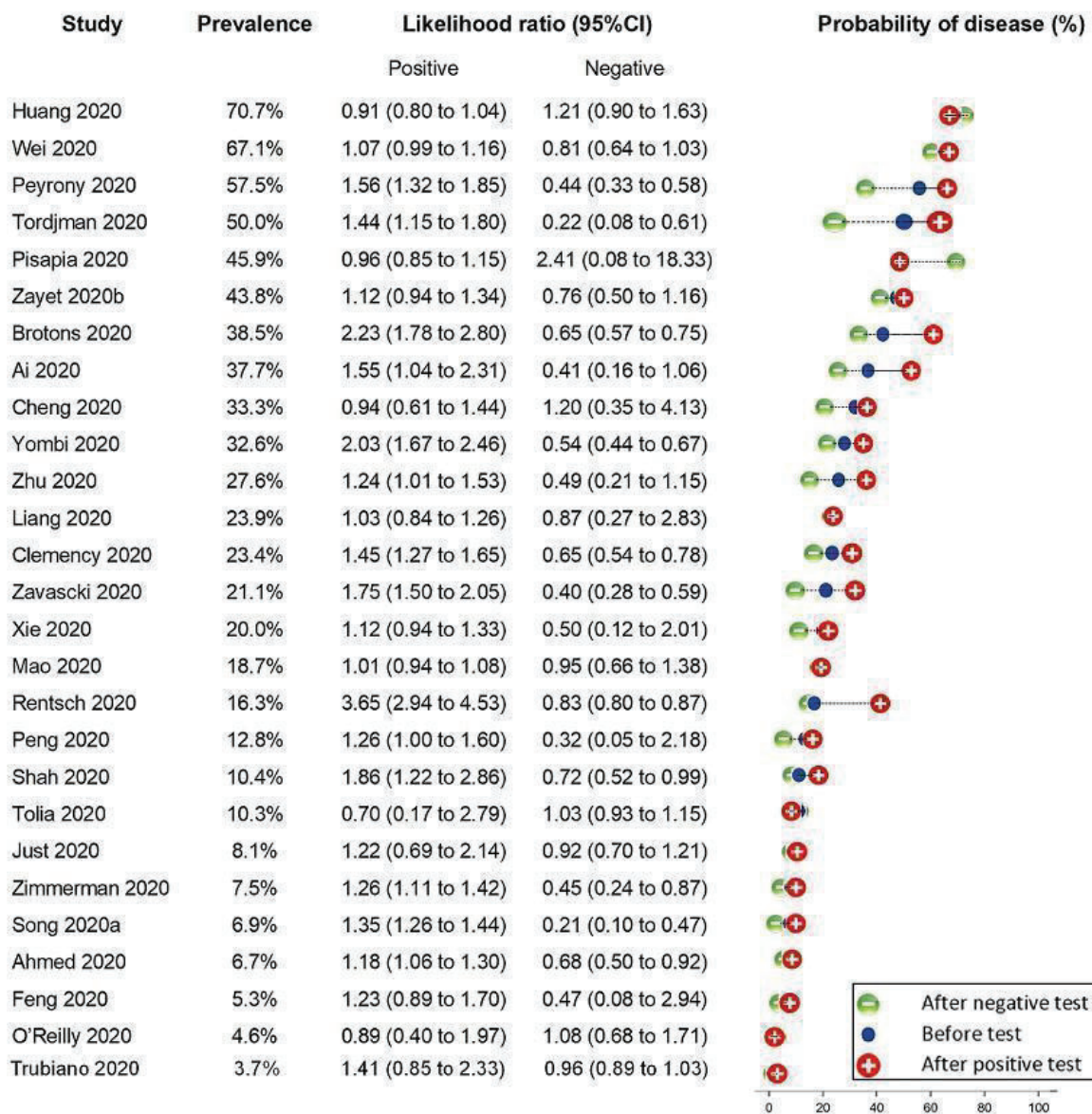
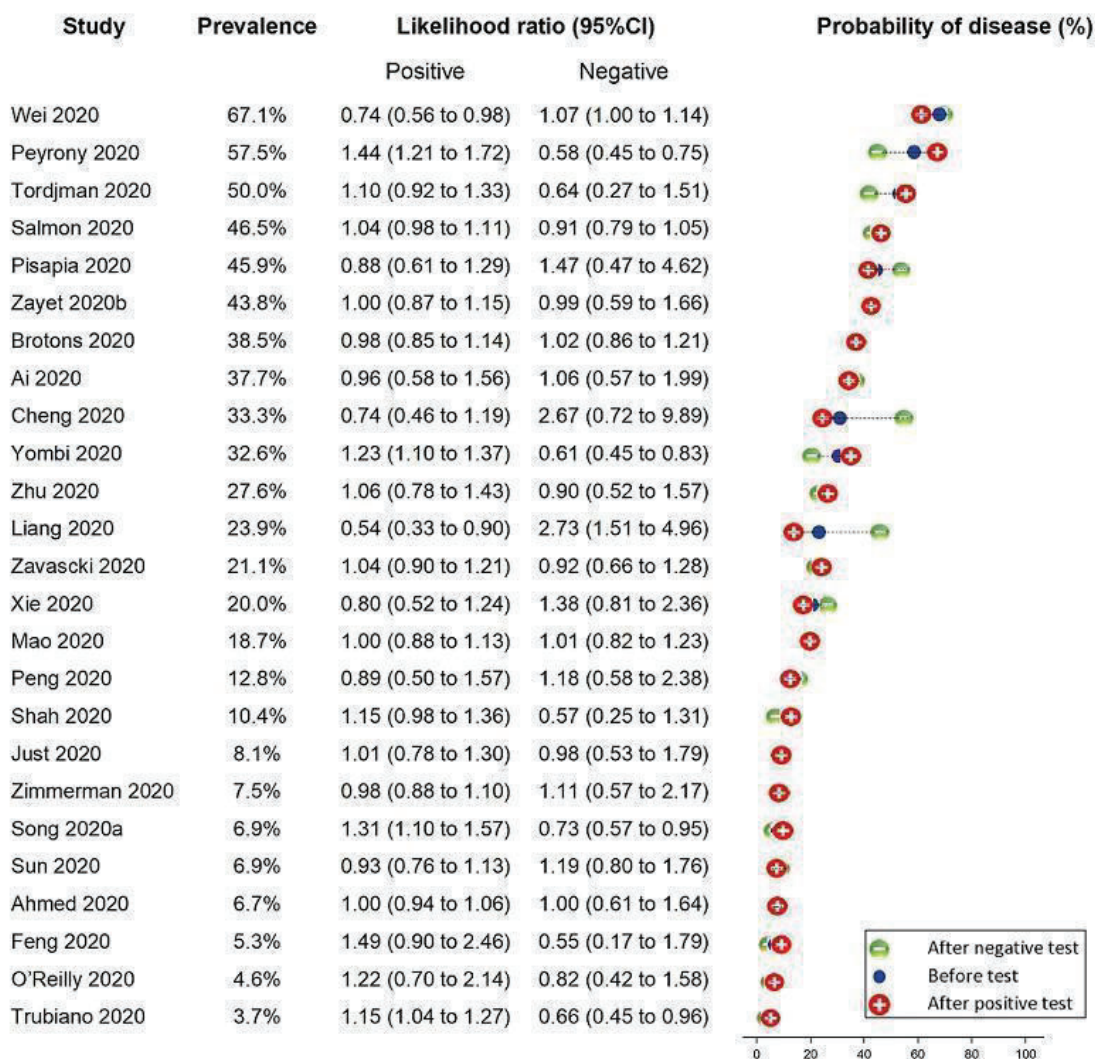


Figure 30. Dumbbell plot: cough. This plot shows how disease probability changes after a positive test result (red dot with plus sign) or after a negative test (green dot with minus sign). Pre-test probability or prevalence is the blue dot



DISCUSSION

Summary of main results

The majority of individual signs and symptoms included in this review appear to have very poor diagnostic accuracy, although this should be interpreted in the context of selection bias and heterogeneity between studies.

Based on currently available data, neither absence nor presence of a single sign or symptom are accurate enough to rule in or rule out COVID-19. However, some combinations of signs and symptoms may be useful as a tool to triage patients for further testing. For

example, combining the tests with the highest positive likelihood ratios in a hypothetical cohort with a disease prevalence (pre-test probability) of 2%, the presence of either anosmia or ageusia would increase the post-test probability of the presence of COVID-19 to 8%. The presence of fever together with myalgia and anosmia would increase the post-test probability to 17.8%.

We did not identify a useful combination of signs or symptoms that can safely rule out COVID-19. For example, in the same hypothetical cohort with 2% disease prevalence, the absence of fever and anosmia would only lower the probability to 1% for the presence of COVID-19. These results should be interpreted with caution as in

reality these tests are correlated making it highly likely they would result in smaller changes in probability if they were tested in actual studies.

The seemingly better sensitivity for fever (and slightly lower specificity) compared to other index tests is unsurprising considering fever was a key feature of COVID-19 that was used in selecting patients for further testing in included studies. As a result, most participants in these studies would have fever, both cases and non-cases. The same applies to olfactory symptoms; only two studies did not select in any way for the presence of olfactory symptoms (Chua 2020; Peyrony 2020), whereas Leal 2020 selected their study participants on the presence of either fever, cough, sore throat, coryza or anosmia. In the studies with no prior selection, less than 10% of the study population presented with anosmia (2.5% in Chua 2020, 9.5% in Peyrony 2020), whereas the study with prior selection reported that 41% had anosmia. Without selection, sensitivity is low and specificity is high (13% to 14% sensitivity and 98% specificity); with prior selection, sensitivity is higher and specificity is lower (56% sensitivity and 70% specificity).

Selection bias is present when selective and non-random inclusion and exclusion of participants applies and the resulting association

between exposure and outcome (here the accuracy of the test) differs in the selected study population compared to the eligible study population, and it has been shown that this may decrease estimates of diagnostic accuracy (Rutjes 2006). For the diagnosis of COVID-19, rapidly and constantly changing, and widely variable test criteria have influenced who was referred for testing and who was not. Inclusion in the study of only a fraction of eligible patients can give a biased estimate of the real accuracy of the index test when measured against the reference standard and real disease status. Griffith 2020 have reported on the problematic presence of collider stratification bias in the published studies on COVID-19. Appropriate sampling strategies need to be applied to avoid conclusions of spurious relationships, more specifically in our case, the biased accuracy estimates of signs and symptoms for the diagnosis of COVID-19. Selection of participants based on the presence of specific pre-set symptoms, such as fever and cough, leads to biased associations between these symptoms and disease, and sensitivity and specificity estimates that differ from their true values. The example of collider bias for cough is illustrated in Figure 31. Grouping studies by diagnostic criteria for selection might clarify this issue, but studies do not clearly describe them, with study authors referring to the guidelines in general that were applicable at the time.

Figure 31. Directed acyclic graph on cough

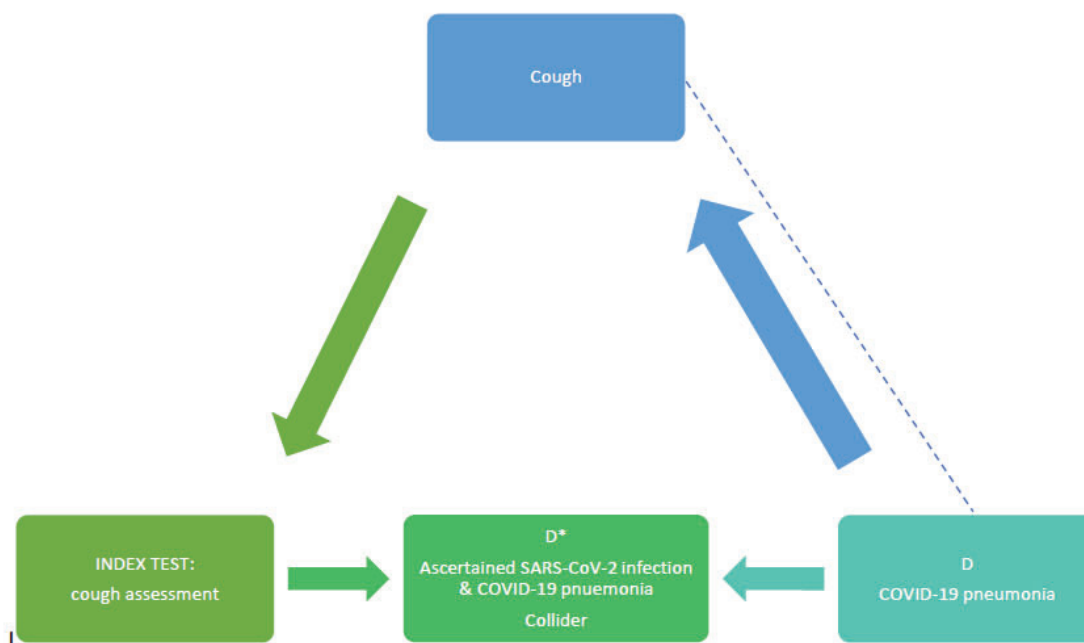


Figure Directed Acyclic Graph (DAG): the symptom, 'cough' is used to enter the study for cough assessment. Both cough and COVID-19 pneumonia (D) result in ascertained diagnosis of SARS-CoV-2 infection (D*). D* is a collider on the pathway between cough and COVID-19 pneumonia leading to a biased association between the symptom cough and COVID-19 pneumonia.

Another form of selection bias is spectrum bias, where the patients included in the studies do not reflect the patient spectrum to which the index test will be applied. The inclusion of hospitalised patients can lead to such a bias, when in these patients both the distribution

of signs and symptoms differ and assessment with the reference standard is differential. In addition, the distribution and severity of alternative diagnoses may be different in hospitalised populations than in patients presenting to ambulatory care settings.

Strengths and weaknesses of the review

Strengths of our review are the systematic and broad search performed to include all possible studies, including those prior to peer-review, to gather the largest number of studies available at this point. Exclusion of cases-only studies, the largest number of the published cohorts of patients with COVID-19, limits the available data, however improves the quality of the evidence and the possibility to present both sensitivity and specificity (cases only cannot provide both accuracy measures). Because this is a living systematic review, this update offered the possibility of pooling estimates of diagnostic accuracy, which was not yet possible in our first review. Future updates will further increase the possibilities of analysing the data in more detail, and focusing the analyses on cross-sectional data that were gathered prospectively.

The largest weakness of the review is the high risk of selection bias, as discussed above, with many studies including patients that had already been admitted to hospital or who presented to hospital settings seeking treatment.

The lack of data on combinations of signs and symptoms is an important evidence gap. Only two studies presented data on such combinations. The few composite signs and symptoms that were presented in those studies had little added diagnostic value compared to single tests. Combinations of tests increased the specificity, but at a large cost in sensitivity, because all signs and symptoms in the composite test had to be present to lead to a positive result. At this point, it is hard to assess the diagnostic value of combinations of signs and symptoms as the existing evidence is too scarce.

We need to assess multiple variables for their possible confounding effect on the summary estimates. Possible confounders include the presence of other respiratory pathogens (seasonality), the phase of the epidemic, exposure to high- versus low-prevalence setting, high or low exposure risk, comorbidity of the participants, or time since infection. Seasonality may influence specificity, because alternative diagnoses such as influenza or other respiratory viruses are more prevalent in winter, leading to more non-COVID-19 patients displaying symptoms such as cough or fever, decreasing specificity. In this version of the review, all studies were conducted in winter or early spring, suggesting this may still have been at play. However, social distancing policies have shortened this year's influenza season in several countries ([who.int/influenza/surveillance_monitoring/updates](https://www.who.int/influenza/surveillance_monitoring/updates)), which may have led to higher specificity for signs and symptoms than what we may expect in the next influenza season. In future updates of the review, we will explore seasonality effects if data allow. As for time since onset, given that the moment of infection is more likely than not an unrecognisable and unmeasurable variable, time since onset of symptoms can be used as a proxy. Reporting of studies, with presentation of the 2x2 table stratified by time since onset of disease, is informative and might have the potential to increase accuracy of the signs and symptoms and their diagnostic differential potential.

Applicability of findings to the review question

The high risk of selection bias, with many studies including patients who had already been admitted to hospital or who presented to hospital settings seeking treatment, leads to findings that are less applicable to people presenting in primary care, who on average

experience a shorter illness duration, less severe symptoms and have a lower probability of the target condition.

Our search did not find any articles providing data on children. Children have been disproportionately underrepresented in the studies on diagnosing SARS-CoV-2 infection. Their absence seems related to the general mild presentation of the disease in the paediatric population and even more frequently the completely asymptomatic course. The full scope of disease presentation in children is, however, not known. It is important to identify signs and symptoms that can be used to assess children with suspected SARS-CoV-2 infection clinically, especially because non-specific presentations and fever without a source are already common in this age group. Children present as a heterogeneous group; having separate data for neonates, young infants, toddlers, school aged children and adolescents is of value. Misclassification of children both at their presentation to the healthcare system and in the short term, where children will be asked to remain in quarantine when they present with predefined, but not yet evidence-based symptoms needs to be avoided to decrease the possible damage done to children's health.

Another important patient group is older adults. They are most at risk of a negative outcome of SARS-CoV-2 infection, especially mortality but also intensive care support. In this version of the review, only one study focused on adults aged 55 to 75 years. All other studies included adults of all ages and did not present results separately for the older age groups. The lack of a solid evidence base for the diagnosis of COVID-19 in older adults adds to the difficulty in diagnosing serious infections in this age group, as other serious infections such as bacterial pneumonia or urinary sepsis also tend to lead to non-specific presentations.

Studies that focus specifically on older adults or children may also enable us to estimate the diagnostic accuracy of signs and symptoms within these age groups. Given the distinct biological characteristics of children versus younger and versus older adults, these accuracy estimates are likely to be different in different age groups. The current presentation of overall pooled estimates may therefore prove too simplistic.

AUTHORS' CONCLUSIONS

Implications for practice

Until results of further studies become available, broad investigation of people with suspected SARS-CoV-2 infection remains necessary. Neither absence nor presence of individual signs are accurate enough to rule in or rule out disease. Within the context of selection bias of all the studies in this review, the presence of fever, cough, or 'anosmia or ageusia' may be useful to identify people for further testing for COVID-19.

Implications for research

Our review update still reflects the need for improved study methodology and reporting in COVID-19 diagnostic accuracy research.

- Appropriate patient sampling strategies; prospective cross-sectional design; investigating the presence or absence of clinical signs and symptoms in anyone with suspected COVID-19
- Improved reporting, with studies describing assessment of signs and symptoms (providing clearer definitions), and clear

reporting of reference standards. Studies should report the definition of signs and symptoms more clearly, how they were measured, by whom and when. The measurement of key symptoms such as anosmia and ageusia could benefit from standardisation, including the severity and nature of the loss of smell or taste. Yet such standardisation should not be overly complicated, as signs and symptoms will typically be used by frontline clinicians who will incorporate these in their more holistic assessment of the patient which includes more than just COVID-19.

- Inclusion of a broader spectrum of patients, with studies in the primary healthcare setting to properly evaluate the diagnostic accuracy of signs and symptoms in this setting; inclusion of studies on patients with the aim of screening for infection (loosening up quarantine measurements may lead to an increased need for this); data on specific patient groups with comorbidities at higher risk of complications or severe disease and higher impact of missing diagnosis of SARS-CoV-2 infection at an early stage; addition of the paediatric population.
- Prospective studies in an unselected population presenting to primary care or hospital outpatient settings, examining combinations of signs and symptoms to evaluate the syndromic presentation of COVID-19, are needed. Results from such studies could inform subsequent management decisions such as self-isolation or selecting patients for further diagnostic testing.
- We would like to recommend that authors adhere to the STARD guidelines when reporting new studies on this topic ([Bossuyt 2015](#)).

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 - * Signs and symptoms (Stuyf T, Domen J, Horn S)
 - * Routine laboratory markers (Yang B, Langendam M, Ochodo E, Guleid F, Holtman G, Verbakel J, Wang J, Stegeman I)

- * Imaging tests (Salameh JP, McGrath TA, van der Pol CB, Frank RA, Prager R, Hare SS, Dennie C, Jenniskens K, Korevaar DA, Cohen JF, van de Wijgert J, Damen JAAG, Wang J)
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CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

Ahmed 2020

Study characteristics

Patient Sampling

Purpose: diagnosis of SARS-Cov-2 infection (mild COVID-19 disease)

Design: retrospective, registry-based study

Recruitment: random subset of manually extracted charts of all patients tested for SARS-CoV-2 in the UHealth system

Sample size: n = 2043 (136 cases)

Inclusion criteria: manual extraction for a random subset of patients tested before 31 March 2020 of all patients having a SARS-CoV-2 test result in the UHealth system. Testing was performed in patients having at least one symptom (cough, fever, or shortness of breath).

Exclusion criteria: none

Ahmed 2020 (Continued)

Patient characteristics and setting

Facility cases: positive SARS-CoV-2 test (specimen and test-type unspecified). Population-level testing. Primarily outpatient settings

Facility controls: negative SARS-CoV-2 test (specimen and test-type unspecified). Population-level testing. Primarily outpatient settings

Country: Utah, USA

Dates: 10 March 2020-31 March 2020

Symptoms and severity: random subset of all tested patients included. Tested if at least one symptom (cough, fever or shortness of breath). Population primarily comprised of mild and moderate infections.

Demographics: median age cases: 38.4 years controls: 39.2 years. Gender: % female cases: 44%, controls: 56% (entire cohort)

Exposure history: % prior exposure: cases: 57%, controls: 29%

Index tests	<ul style="list-style-type: none"> • Cough • Fever • Shortness of breath • Lethargy • Myalgia • Headache • Sore throat • Nasal symptoms • Diarrhea • Nausea/vomiting
Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: SARS-CoV-2 infection • RS: not specified
Flow and timing	Time interval not specified
Comparative	
Notes	

Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Yes		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		Low risk	

Signs and symptoms to determine if a patient presenting in primary care or hospital outpatient settings has COVID-19 (Review)

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Ahmed 2020 (Continued)

Are there concerns that the included patients and setting do not match the review question?	Low concern
DOMAIN 2: Index Test (All tests)	
Were the index test results interpreted without knowledge of the results of the reference standard?	Unclear
If a threshold was used, was it pre-specified?	Unclear
Could the conduct or interpretation of the index test have introduced bias?	High risk
Are there concerns that the index test, its conduct, or interpretation differ from the review question?	Low concern
DOMAIN 3: Reference Standard	
Is the reference standards likely to correctly classify the target condition?	Unclear
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear
Could the reference standard, its conduct, or its interpretation have introduced bias?	Unclear risk
Are there concerns that the target condition as defined by the reference standard does not match the question?	Low concern
DOMAIN 4: Flow and Timing	
Was there an appropriate interval between index test and reference standard?	Unclear
Did all patients receive the same reference standard?	Unclear
Were all patients included in the analysis?	Yes
Could the patient flow have introduced bias?	Unclear risk

Ai 2020

Study characteristics	
Patient Sampling	<p>Purpose: diagnosis of SARS-CoV-2 pneumonia</p> <p>Design: cross-sectional multicentre prospective study</p> <p>Recruitment: hospitalised pneumonia patients</p> <p>Sample size: n = 53 (20 cases)</p> <p>Inclusion criteria: suspected SARS-CoV-2 pneumonia patients, defined as having pneumonia after chest CT (with 1 of the 2 following criteria met:</p>

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Ai 2020 (Continued)

	fever or respiratory symptoms, normal or decreased WBC counts/decreased)
	Exclusion criteria: not defined
Patient characteristics and setting	<p>Facility cases: confirmed case: a positive SARS-CoV-2 nucleotides result either by metagenomic sequencing or RT-PCR assay for nasopharyngeal swab specimens</p> <p>Facility controls: pneumonia patients confirmed not to be infected by SARS-CoV-2 (2 PCR tests, 2 days in between)</p> <p>Country: China</p> <p>Dates: 22 January 2020-19 February 2020</p> <p>Symptoms and severity: suspected SARS-CoV-2 pneumonia (NCP): having pneumonia after chest CT with 1 of the 2 following criteria met: fever or respiratory symptoms, normal or decreased WBC counts/decreased lymphocyte counts, and a travel history or contact with patients with fever or respiratory symptoms from Hubei Province or confirmed cases within 2 weeks</p> <p>Demographics: median age cases 37 years, controls 39 years, gender distribution cases (M/F: 50/50), controls (M/F: 48.5/51.5)</p> <p>Exposure history: not specified</p>
Index tests	<ul style="list-style-type: none"> • Fever • Dry cough • Diarrhoea • Fatigue • Headache • Vomiting • Abdominal pain
Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: COVID-19 pneumonia • RS: a positive SARS-CoV-2 nucleotides result either by metagenomic sequencing or RT-PCR assay for nasopharyngeal swab specimens, repeated after 2 days if negative on day 0
Flow and timing	Time interval not specified. Reference standard at day 0 and day 2, index tests from electronic medical records but stated at pneumonia onset
Comparative	
Notes	

Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Unclear		
Was a case-control design avoided?	Yes		

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Ai 2020 (Continued)

Did the study avoid inappropriate exclusions?	Unclear
Did the study avoid inappropriate inclusions?	No
Could the selection of patients have introduced bias?	High risk
Are there concerns that the included patients and setting do not match the review question?	High
DOMAIN 2: Index Test (All tests)	
Were the index test results interpreted without knowledge of the results of the reference standard?	Unclear
If a threshold was used, was it pre-specified?	No
Could the conduct or interpretation of the index test have introduced bias?	High risk
Are there concerns that the index test, its conduct, or interpretation differ from the review question?	Low concern
DOMAIN 3: Reference Standard	
Is the reference standards likely to correctly classify the target condition?	Yes
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear
Could the reference standard, its conduct, or its interpretation have introduced bias?	Low risk
Are there concerns that the target condition as defined by the reference standard does not match the question?	Low concern
DOMAIN 4: Flow and Timing	
Was there an appropriate interval between index test and reference standard?	Unclear
Did all patients receive the same reference standard?	Yes
Were all patients included in the analysis?	Yes
Could the patient flow have introduced bias?	Low risk

Brotons 2020

Study characteristics

Patient Sampling

Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); to measure the seroprevalence of antibodies against SARS-

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Brotons 2020 (Continued)

CoV-2 infection in a community sample of asymptomatic and symptomatic patients.

Design: multicenter prospective cohort

Recruitment: patients with mild or moderate COVID-19 symptoms who had a face-to-face or phone consultation with their GP between 2 March and 24 April 2020

Sample size: n = 634 (244 cases)

Inclusion criteria: all patients aged ≥ 1 year consulting the primary care physician either face-to-face or by phone with mild or moderate symptoms (without a confirmed diagnosis) during the COVID-19 pandemic from 2 March-24 April 2020

Exclusion criteria: none

Patient characteristics and setting

Facility cases:

Facility controls:

Country: Spain

Dates: 2 March 2020-24 April 2020

Symptoms and severity: mild to moderate symptoms

Demographics: mean age: 46.97 years. Gender: % female cases: 55.3% cases, 59.23% controls

Exposure history: contact: cases 50.82%, controls 38.97%

Index tests

- Cough
- Tiredness
- Headache
- Fever ($> 38^{\circ}\text{C}$)
- Diarrhea
- Dyspnea
- Ageusia
- Anosmia
- Sore throat
- Low-grade fever ($37.5\text{-}38^{\circ}\text{C}$)
- Shaking chills
- Nausea/vomiting
- Skin lesions

Target condition and reference standard(s)

- TC: SARS-CoV-2 infection
- RS: positive serology for SARS-CoV-2 (IgM and/or IgG)

Flow and timing

Reported on the same day, patients were sick between 10 days-40 days before (recall bias risk)

Comparative

Notes

Methodological quality

Brotons 2020 (Continued)

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Yes		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		Low risk	
Are there concerns that the included patients and setting do not match the review question?			Low concern
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Unclear		
If a threshold was used, was it pre-specified?	Unclear		
Could the conduct or interpretation of the index test have introduced bias?		Unclear risk	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?			High
DOMAIN 3: Reference Standard			
Is the reference standards likely to correctly classify the target condition?	No		
Were the reference standard results interpreted without knowledge of the results of the index tests?	Yes		
Could the reference standard, its conduct, or its interpretation have introduced bias?		High risk	
Are there concerns that the target condition as defined by the reference standard does not match the question?			High
DOMAIN 4: Flow and Timing			
Was there an appropriate interval between index test and reference standard?	No		
Did all patients receive the same reference standard?	No		
Were all patients included in the analysis?	No		
Could the patient flow have introduced bias?		High risk	

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Carignan 2020

Study characteristics

Patient Sampling	<p>Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); to assess whether anosmia and dysgeusia are specific symptoms for SARS-CoV-2</p> <p>Design: case-control study</p> <p>Recruitment: all adult patients who underwent testing for SARS-CoV-2 at the CHUS (Centre Hospitalier de Sherbrooke), cases: all positives, controls: random sample</p> <p>Sample size: n = 268 (134 cases)</p> <p>Inclusion criteria: the criteria for SARS-CoV-2 testing included symptomatic (fever, cough or dyspnea) travellers and contacts of confirmed COVID-19 cases. All adult patients (≥ 18 years) who underwent testing were included.</p> <p>Exclusion criteria: patients with multiple tests during the study period</p>
Patient characteristics and setting	<p>Facility cases: all adult (age ≥ 18 years) patients testing positive for SARS-CoV-2 by means of RT-PCR</p> <p>Facility controls: matched (1:1) according to 5-year age groups selected by means of a pseudorandom number generator from all patients who tested negative for SARS-CoV-2 at the CHUS during the same period</p> <p>Country: Quebec, Canada</p> <p>Dates: 10 March 2020-23 March 2020</p> <p>Symptoms and severity: mild to moderate severity</p> <p>Demographics: median age: cases: 57.1 years, controls: 57.2 years gender: % female cases: 52.2%, controls: 60.4%</p> <p>Exposure history: not specified</p>
Index tests	<ul style="list-style-type: none"> • Anosmia • Dysgeusia • Anosmia and/or dysgeusia • Asthenia • Myalgia • Arthralgia • Chest pain • Dyspnea • Chills • Fever (subjective) • Fever (objective) • Nasal congestion • Nasal drip • Sneezing • Sore throat • Cough • Sputum production • Loss of appetite • Nausea

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Carignan 2020 (Continued)

- Vomiting
- Diarrhoea
- Headaches
- Red eyes
- Rash
- Vertigo or dizziness
- Blurred vision
- Loss of temperature sensation in face

Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: SARS-CoV-2 infection • RS: RT-PCR (assay limit of detection = 200 SARS-CoV-2 RNA copies/mL)
Flow and timing	Index tests within 72 h before or after SARS-CoV-2 testing (in reality: 3-15 days)
Comparative	
Notes	

Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	No		
Did the study avoid inappropriate exclusions?	No		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		High risk	
Are there concerns that the included patients and setting do not match the review question?			Low concern
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	No		
If a threshold was used, was it pre-specified?	No		
Could the conduct or interpretation of the index test have introduced bias?		High risk	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?			Low concern
DOMAIN 3: Reference Standard			

Carignan 2020 (Continued)

Is the reference standards likely to correctly classify the target condition?	Yes
Were the reference standard results interpreted without knowledge of the results of the index tests?	Yes
Could the reference standard, its conduct, or its interpretation have introduced bias?	Low risk
Are there concerns that the target condition as defined by the reference standard does not match the question?	Low concern
DOMAIN 4: Flow and Timing	
Was there an appropriate interval between index test and reference standard?	No
Did all patients receive the same reference standard?	Yes
Were all patients included in the analysis?	Yes
Could the patient flow have introduced bias?	High risk

Challener 2020

Study characteristics

Patient Sampling	<p>Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); to determine predictors of a positive test for COVID-19</p> <p>Design: case-control</p> <p>Recruitment: retrospective review of medical records of patients with the first 48 positive tests and a matched random selection of 98 patients with negative tests</p> <p>Sample size: n = 146 (48 cases)</p> <p>Inclusion criteria: all consecutive patients screened for SARS-CoV-2 (suspicion based on presenting symptoms, > 80% of cases and controls had fever and/or cough)</p> <p>Exclusion criteria: none specified</p>
Patient characteristics and setting	<p>Facility cases: the first 48 patients with a RT-PCR-positive test for SARS-CoV-2</p> <p>Facility controls: SARS-CoV-2-negative patients that were selected randomly and matched by age (+/- 5 years), sex, collection date, and testing location (Minnesota, Wisconsin, or Arizona) with the positive patients</p> <p>Country: Minnesota, USA</p> <p>Dates: 12 March 2020-26 March 2020</p>

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Challenger 2020 (Continued)

Symptoms and severity: mild to moderate severity, few co-morbidities

Demographics: mean age: cases: 45.9 years, controls: 46.0 years. Gender: % female cases: 46.0%, controls: 38.0%

Exposure history: close exposure to lab-confirmed case of COVID-19: cases: 29.5%, controls: 5.6%

Index tests	<ul style="list-style-type: none"> Cough Fever
Target condition and reference standard(s)	<ul style="list-style-type: none"> TC: SARS-CoV-2 infection RS: RT-PCR
Flow and timing	Reference standard immediately after index tests
Comparative	
Notes	

Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	No		
Did the study avoid inappropriate exclusions?	Yes		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		High risk	
Are there concerns that the included patients and setting do not match the review question?			Low concern
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes		
If a threshold was used, was it pre-specified?	Unclear		
Could the conduct or interpretation of the index test have introduced bias?		High risk	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?			Low concern
DOMAIN 3: Reference Standard			

Challener 2020 (Continued)

Is the reference standards likely to correctly classify the target condition?	Yes
Were the reference standard results interpreted without knowledge of the results of the index tests?	Yes
Could the reference standard, its conduct, or its interpretation have introduced bias?	Low risk
Are there concerns that the target condition as defined by the reference standard does not match the question?	Low concern
DOMAIN 4: Flow and Timing	
Was there an appropriate interval between index test and reference standard?	Yes
Did all patients receive the same reference standard?	Yes
Were all patients included in the analysis?	Yes
Could the patient flow have introduced bias?	Low risk

Chen 2020

Study characteristics

Patient Sampling	<p>Purpose: diagnosis of COVID-19 pneumonia - to identify differences in CT imaging and clinical manifestations between pneumonia patients with and without COVID-19, and to develop and validate a diagnostic model for COVID-19 based on radiological semantic and clinical features</p> <p>Design: cross-sectional, multicentre, retrospective study</p> <p>Recruitment: cases: consecutive patients with COVID-19 admitted in 5 independent hospitals; controls: at the same period, another 66 consecutive pneumonia patients without COVID-19 from Meizhou People's Hospital</p> <p>Sample size: n = 136 (cases = 70)</p> <p>Inclusion criteria: patients admitted with COVID-19 pneumonia (cases) and patients admitted with non-COVID-19 pneumonia (controls)</p> <p>Exclusion criteria: not specified for cases except those from 1 hospital (Meizhou), for cases and controls in Meizhou: after chest CT neoplasm, tuberculosis, pulmonary oedema, pulmonary contusion, aspiration pneumonia, bronchitis, any local or systemic treatment before CT scan, normal CT image without epidemiological history</p>
Patient characteristics and setting	<p>Facility cases: pneumonia patients with positive SARS-CoV-2 test</p> <p>Facility controls: CT pneumonia patients with consecutive negative RT-PCR</p> <p>Country: China</p> <p>Dates: 1 January 2020-8 February 2020</p>

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Chen 2020 (Continued)

Symptoms and severity: pneumonia patients for cases and control; unclear severity of cases

Demographics: M/F: cases 41/29, controls 43/23
mean age: cases 42.9 range, 16-69 years, controls 46.7 range, 0.3-93 years

Exposure history: data about exposure to epidemic centres collected, but no results in the study nor in appendices

Index tests	<ul style="list-style-type: none">• Systolic BP• Diastolic BP• Respiration rate• Heart rate• Temperature• Dry cough• Fatigue• Sore throat• Stuffy• Runny nose		
Target condition and reference standard(s)	<ul style="list-style-type: none">• TC: COVID-19 pneumonia• RS: RT-PCR and next generation sequencing for SARS-CoV-2		
Flow and timing	Time interval not specified		
Comparative			
Notes			
Methodological quality			
Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Yes		
Did the study avoid inappropriate inclusions?	No		
Could the selection of patients have introduced bias?		High risk	
Are there concerns that the included patients and setting do not match the review question?			High
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Unclear		

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Chen 2020 (Continued)

If a threshold was used, was it pre-specified?	No
Could the conduct or interpretation of the index test have introduced bias?	Unclear risk
Are there concerns that the index test, its conduct, or interpretation differ from the review question?	Unclear
DOMAIN 3: Reference Standard	
Is the reference standards likely to correctly classify the target condition?	Yes
Were the reference standard results interpreted without knowledge of the results of the index tests?	Yes
Could the reference standard, its conduct, or its interpretation have introduced bias?	Low risk
Are there concerns that the target condition as defined by the reference standard does not match the question?	Low concern
DOMAIN 4: Flow and Timing	
Was there an appropriate interval between index test and reference standard?	Unclear
Did all patients receive the same reference standard?	Yes
Were all patients included in the analysis?	Yes
Could the patient flow have introduced bias?	Low risk

Cheng 2020

Study characteristics

Patient Sampling

Purpose: to identify the clinical features and CT manifestations of COVID-19 and compare them with those of pneumonia occurring in patients who do not have COVID-19

Design: cross-sectional, single-centre, retrospective study

Recruitment: pneumonia patients who presented at a fever observation department in Shanghai

Sample size: n = 33 (11 cases)

Inclusion criteria: patients with clinical and radiological features of pneumonia, and a normal or reduced total leukocyte count or total lymphocyte count, plus an epidemiologic history that included travel or a history of residence in Hubei Province or other areas where continuous transmission of local cases occurred within 14 days before onset of symptoms, a history of contact with patients who had fever or respiratory symptoms and were from Hubei Province or other areas with continuous transmission of local cases within 14 days before onset of the disease, or clustering or epidemiologic association with the new coronavirus infection

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Cheng 2020 (Continued)

Exclusion criteria: not defined

Patient characteristics and setting	<p>Facility cases: confirmed case: positive RT-PCR test result obtained by a throat swab. Test was repeated when the first test was negative</p> <p>Facility controls: pneumonia patients confirmed not to be infected by SARS-CoV-2 (2 PCR tests)</p> <p>Country: China</p> <p>Dates: 19 January 2020-6 February 2020</p> <p>Symptoms and severity: pneumonia was defined as patients with at least 1 clinical symptom (i.e. cough, sputum, fever, dyspnoea, or pleuritic chest pain), a finding of either coarse crackles on auscultation or elevated inflammatory biomarkers, and observation of a new pulmonary opacification on chest CT</p> <p>Demographics: median age \pm SD cases 50.36 ± 15.5, controls 43.59 ± 16.02, gender distribution cases (M/F: 8/3), controls (M/F: 7/15)</p> <p>Exposure history: cases 8/11, controls 7/22 (in the last 14 days with patients with fever or respiratory symptoms or with known cases)</p>
Index tests	<ul style="list-style-type: none"> • Fever • Cough • Sputum • Shortness of breath • Muscle ache • Diarrhoea • Sore throat • Peak body temperature
Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: COVID-19 pneumonia • RS: RT-PCR testing on throat swab specimens <p>Tests were repeated if the first test was negative</p>
Flow and timing	Time interval not specified, reference test at day 0 (or later when the first test was negative), index tests were questioned at day 0 for the presence of symptoms in the past period of time
Comparative	
Notes	

Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Unclear		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Unclear		

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Cheng 2020 (Continued)

Did the study avoid inappropriate inclusions?	No	
Could the selection of patients have introduced bias?		High risk
Are there concerns that the included patients and setting do not match the review question?		High
DOMAIN 2: Index Test (All tests)		
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes	
If a threshold was used, was it pre-specified?	No	
Could the conduct or interpretation of the index test have introduced bias?		High risk
Are there concerns that the index test, its conduct, or interpretation differ from the review question?		Low concern
DOMAIN 3: Reference Standard		
Is the reference standards likely to correctly classify the target condition?	Yes	
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear	
Could the reference standard, its conduct, or its interpretation have introduced bias?		Low risk
Are there concerns that the target condition as defined by the reference standard does not match the question?		Low concern
DOMAIN 4: Flow and Timing		
Was there an appropriate interval between index test and reference standard?	Unclear	
Did all patients receive the same reference standard?	Yes	
Were all patients included in the analysis?	Yes	
Could the patient flow have introduced bias?		Low risk

Chua 2020

Study characteristics

Patient Sampling	<p>Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); to evaluate the utility of acute olfactory loss as a risk- stratifying tool for COVID-19</p> <p>Design: retrospective cohort study</p> <p>Recruitment: chart review was performed for all patients who presented with acute respiratory symptoms, and in those who fulfilled the prevailing Ministry of Health suspect or surveillance case definition, at ED of tertiary hospital</p> <p>Sample size: n = 688 (24 cases)</p> <p>Inclusion criteria: all patients with suspected SARS-CoV-2 infection (suspicion based on presence of acute respiratory symptoms, and fulfilling the prevailing Ministry of Health suspect or surveillance case definition)</p> <p>Exclusion criteria: patients with pre-existing olfactory loss, and those who were unable to give a history of olfactory loss reliably (e.g. those with cognitive impairment)</p>		
Patient characteristics and setting	<p>Facility cases: suspected patients with a positive PCR test</p> <p>Facility controls: suspected patients with a negative PCR test</p> <p>Country: Singapore</p> <p>Dates: 23 March 2020-04 April 2020</p> <p>Symptoms and severity: not specified</p> <p>Demographics: age: not specified gender: not specified</p> <p>Exposure history: not specified</p>		
Index tests	<ul style="list-style-type: none">• Hyposmia• Anosmia		
Target condition and reference standard(s)	<ul style="list-style-type: none">• TC: SARS-CoV-2 infection• RS: RT-PCR (oropharyngeal swab)		
Flow and timing	RS and index tests both taken at presentation		
Comparative			
Notes			
Methodological quality			
Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	Yes		

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Chua 2020 (Continued)

Did the study avoid inappropriate exclusions?	Yes	
Did the study avoid inappropriate inclusions?	Yes	
Could the selection of patients have introduced bias?		Low risk
Are there concerns that the included patients and setting do not match the review question?		Unclear
DOMAIN 2: Index Test (All tests)		
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes	
If a threshold was used, was it pre-specified?	Unclear	
Could the conduct or interpretation of the index test have introduced bias?		High risk
Are there concerns that the index test, its conduct, or interpretation differ from the review question?		Low concern
DOMAIN 3: Reference Standard		
Is the reference standards likely to correctly classify the target condition?	Yes	
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear	
Could the reference standard, its conduct, or its interpretation have introduced bias?		Low risk
Are there concerns that the target condition as defined by the reference standard does not match the question?		Low concern
DOMAIN 4: Flow and Timing		
Was there an appropriate interval between index test and reference standard?	Yes	
Did all patients receive the same reference standard?	Yes	
Were all patients included in the analysis?	Yes	
Could the patient flow have introduced bias?		Low risk

Clemency 2020

Study characteristics		
Patient Sampling	Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); to develop symptom-based criteria for screening of HCW for SARS-CoV-2	

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Clemency 2020 (Continued)

	<p>Design: prospective observational cohort</p> <p>Recruitment: HCW with symptoms concerning for COVID-19 infection were evaluated for potential testing through a centralised nurse call center and referred to outpatient drive-through testing sites if any suspicion of infection</p> <p>Sample size: n = 961 (225 cases)</p> <p>Inclusion criteria: all HCW tested for SARS-CoV-2, based on symptom-based triage ("symptoms concerning for COVID-19 infection")</p> <p>Exclusion criteria: none specified (141 excluded because symptoms were not documented, 12 excluded because test results not available)</p>
Patient characteristics and setting	<p>Facility cases: all consecutive HCW with a single positive RT-PCR test for SARS-CoV-2</p> <p>Facility controls: all consecutive HCW with a single negative RT-PCR test for SARS-CoV-2</p> <p>Country: New York, USA</p> <p>Dates: 26 March 2020-16 April 2020</p> <p>Symptoms and severity: mild to moderate severity, inclusion based on presenting symptoms</p> <p>Demographics: mean age: not presented gender: not presented</p> <p>Exposure history: not presented (likely a high rate of exposure, because HCW)</p>
Index tests	<ul style="list-style-type: none"> • Fever • Fatigue • Dry cough • Loss of appetite • Myalgia • Difficulty breathing • Coughing up phlegm • Sore throat • Diarrhoea • Loss of taste or smell
Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: SARS-CoV-2 infection • RS: (single) RT-PCR, nasopharyngeal or oropharyngeal swabs
Flow and timing	HCW referred for reference test after index test, but exact time interval not specified
Comparative	
Notes	
Methodological quality	
Item	Authors' judgement Risk of bias Applicability concerns

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Clemency 2020 (Continued)

DOMAIN 1: Patient Selection

Was a consecutive or random sample of patients enrolled?	Yes	
Was a case-control design avoided?	Yes	
Did the study avoid inappropriate exclusions?	Yes	
Did the study avoid inappropriate inclusions?	Yes	
Could the selection of patients have introduced bias?		Low risk
Are there concerns that the included patients and setting do not match the review question?		Low concern

DOMAIN 2: Index Test (All tests)

Were the index test results interpreted without knowledge of the results of the reference standard?	Yes	
If a threshold was used, was it pre-specified?	Unclear	
Could the conduct or interpretation of the index test have introduced bias?		High risk
Are there concerns that the index test, its conduct, or interpretation differ from the review question?		Low concern

DOMAIN 3: Reference Standard

Is the reference standards likely to correctly classify the target condition?	Yes	
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear	
Could the reference standard, its conduct, or its interpretation have introduced bias?		Low risk
Are there concerns that the target condition as defined by the reference standard does not match the question?		Low concern

DOMAIN 4: Flow and Timing

Was there an appropriate interval between index test and reference standard?	Unclear	
Did all patients receive the same reference standard?	Yes	
Were all patients included in the analysis?	Yes	
Could the patient flow have introduced bias?		Low risk

Feng 2020

Study characteristics

Patient Sampling

Purpose: diagnosis of COVID-19 pneumonia

Design: cross-sectional, retrospective, single-centre study

Recruitment: patients admitted to ED with history of exposure to COVID-19

Sample size: n = 132 (cases = 7)

Inclusion criteria: all patients admitted to the fever clinic of the ED of the First Medical Center, Chinese People's Liberation Army General Hospital (PLAGH) in Beijing with the epidemiological history of exposure to COVID-19 according to WHO interim guidance

Exclusion criteria: < 14 years old, no other criteria specified

Patient characteristics and setting

Facility cases: among clinically suspected patients: those with a positive RT-PCR

Facility controls: clinically non-suspected patients + suspected patients with negative RT-PCR

Country: China

Dates: 14 January 2020-9 February 2020

Symptoms and severity: all patients admitted, with exposure history to COVID-19, so all levels of severity; days from illness onset until admission (median, IQR): 2.0 (1.0-5.0); patient population with general mild disease and limited presence of comorbidities (range 0%-2.3% (COPD))

Demographics: age: controls median 40.0 years (IQR 32.5-54.5), cases median 39.0 years (IQR 37.0-41.5)

M%/F%: cases 71.4/28.6, controls 63.2/36.8

Exposure history: epidemiological history of exposure to COVID-19 (as per WHO guidance)

Index tests

- Heart rate
- Diastolic BP
- Systolic BP
- Fever (former: median only on all and cases - no control median given)
- Highest temperature
- Cough
- Shortness of breath
- Muscle ache
- Headache
- Sore throat
- Rhinorrhoea
- Diarrhoea
- Nausea
- Vomiting
- Chills
- Shiver
- Expectoration
- Abdominal pain

Feng 2020 (Continued)

- Fatigue
- Palpitation

Target condition and reference standard(s)	<ul style="list-style-type: none">• TC: COVID-19 pneumonia• RS: in-house RT-PCR (E-gene) - at 4 institutions		
Flow and timing	Index test and RS both taken on admission		
Comparative			
Notes			
Methodological quality			
Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Yes		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		Low risk	
Are there concerns that the included patients and setting do not match the review question?			Low concern
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes		
If a threshold was used, was it pre-specified?	No		
Could the conduct or interpretation of the index test have introduced bias?		High risk	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?			Low concern
DOMAIN 3: Reference Standard			
Is the reference standards likely to correctly classify the target condition?	Yes		
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear		
Could the reference standard, its conduct, or its interpretation have introduced bias?		High risk	

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Feng 2020 (Continued)

Are there concerns that the target condition as defined by the reference standard does not match the question?		Low concern
DOMAIN 4: Flow and Timing		
Was there an appropriate interval between index test and reference standard?	Yes	
Did all patients receive the same reference standard?	No	
Were all patients included in the analysis?	Yes	
Could the patient flow have introduced bias?		High risk

Gilbert 2020

Study characteristics	
Patient Sampling	<p>Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease)</p> <p>Design: prospective cohort, including consecutive patients with suspected SARS-CoV-2 infection</p> <p>Recruitment: all patients presenting to the ED triage center with symptoms suggestive of COVID-19</p> <p>Sample size: n = 598 (175 cases)</p> <p>Inclusion criteria: all consecutive patients suspected of SARS-CoV-2 infection and directed to the triage centres located close to the EDs and subjected to SARS-CoV-2 testing; suspicion = respiratory symptoms and/or fever in a healthcare provider, an immunosuppressed patient or a nursing home resident, and all patients who required an admission to the hospital</p> <p>Exclusion criteria: none</p>
Patient characteristics and setting	<p>Facility cases: RT-PCR-positive patients</p> <p>Facility controls: RT-PCR-negative patients</p> <p>Country: Belgium</p> <p>Dates: 02 March 2020-23 March 2020</p> <p>Symptoms and severity: consecutive patients (selection based on PCR testing), mild to moderate severity (83% sent home for self-isolation, 1.9% ICU, 15% hospital admission)</p> <p>Demographics: mean age (all): 41.1 years gender: % female (all): 59.0%</p> <p>Exposure history: travel to endemic country: cases 5.1%, controls 12.5% contact with positive patients: cases: 10.9%, controls 9.0%</p>
Index tests	<ul style="list-style-type: none"> Flu-like symptoms (myalgia, asthenia, fever) Mild lower respiratory tract infection symptoms (cough, fever, sputum) Moderate lower respiratory tract infection symptoms (cough, fever, sputum, dyspnea)

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Gilbert 2020 (Continued)

- Upper respiratory tract infection symptoms (sore throat, nasal congestion, sneezing, mild fever)
- Respiratory distress signs/symptoms (dyspnoea, cough, fever, low oxygen saturation)
- Isolated fever
- Isolated headache
- Digestive symptoms (diarrhoea, nausea)

Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: SARS-CoV-2 infection • RS: RT-PCR, nasopharyngeal swabs (> 1 if deemed necessary)
Flow and timing	Index tests followed by reference standard
Comparative	
Notes	

Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	No		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	No		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		High risk	
Are there concerns that the included patients and setting do not match the review question?			High
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes		
If a threshold was used, was it pre-specified?	No		
Could the conduct or interpretation of the index test have introduced bias?		High risk	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?			Low concern
DOMAIN 3: Reference Standard			
Is the reference standards likely to correctly classify the target condition?	Yes		

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Gilbert 2020 (Continued)

Were the reference standard results interpreted without knowledge of the results of the index tests? Unclear

Could the reference standard, its conduct, or its interpretation have introduced bias?

Low risk

Are there concerns that the target condition as defined by the reference standard does not match the question?

Low concern

DOMAIN 4: Flow and Timing

Was there an appropriate interval between index test and reference standard? Yes

Did all patients receive the same reference standard? Yes

Were all patients included in the analysis? Yes

Could the patient flow have introduced bias?

Low risk

Haehner 2020

Study characteristics

Patient Sampling

Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); to investigate the frequency of olfactory loss in an outpatient population who presented to a coronavirus testing center. To evaluate the diagnostic value of the symptom "sudden smell loss" for screening procedures.

Design: cross-sectional cohort study (prospective data collection)

Recruitment: patients who presented with symptoms of a common cold to a coronavirus testing centre and fulfilled coronavirus testing criteria.

Sample size: n = 500 (cases 34)

Inclusion criteria: patients with common cold complaints who met the criteria for SARS-CoV-2 testing to WHO recommendations

Exclusion criteria: none

Patient characteristics and setting

Facility cases: RT-PCR for SARS-CoV-2 positive

Facility controls: RT-PCR for SARS-CoV-2 negative

Country: Germany

Dates: not specified

Symptoms and severity: olfactory loss

Demographics: mean age: 41.3 years gender % female: 54.6%

Exposure history: not specified

Haehner 2020 (Continued)

Index tests	Olfactory loss		
Target condition and reference standard(s)	<ul style="list-style-type: none">• TC: SARS-CoV-2 infection• RS: RT-PCR, samples from throat swabs		
Flow and timing	RS and index test taken on the same day		
Comparative			
Notes			
Methodological quality			
Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Yes		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		Low risk	
Are there concerns that the included patients and setting do not match the review question?			Low concern
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes		
If a threshold was used, was it pre-specified?	No		
Could the conduct or interpretation of the index test have introduced bias?		Low risk	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?			Low concern
DOMAIN 3: Reference Standard			
Is the reference standards likely to correctly classify the target condition?	Yes		
Were the reference standard results interpreted without knowledge of the results of the index tests?	Yes		
Could the reference standard, its conduct, or its interpretation have introduced bias?		Low risk	

Haehner 2020 (Continued)

Are there concerns that the target condition as defined by the reference standard does not match the question?		Low concern
DOMAIN 4: Flow and Timing		
Was there an appropriate interval between index test and reference standard?	Yes	
Did all patients receive the same reference standard?	Yes	
Were all patients included in the analysis?	Yes	
Could the patient flow have introduced bias?		Low risk

Huang 2020

Study characteristics	
Patient Sampling	<p>Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); to explore a novel risk score to predict diagnosis with COVID-19 among all suspected patients at admission</p> <p>Design: retrospective, multicentre, observational study</p> <p>Recruitment: retrospective chart review of patients admitted into 26 COVID-19 designated hospitals in Sichuan Province, China</p> <p>Sample size: n = 475 (336 cases)</p> <p>Inclusion criteria: patients with suspected COVID-19 (suspected case is defined as having exposure history and 2 clinical manifestations. Patients without epidemiological exposure histories could also be seen as 'suspected COVID-19' only if 3 clinical manifestations were present.</p> <p>Exclusion criteria: none</p>
Patient characteristics and setting	<p>Facility cases: suspected patients with a positive RT-PCR test</p> <p>Facility controls: suspected patients with a negative RT-PCR test. If the first test was negative, at least a second test was done, 24 h apart.</p> <p>Country: China</p> <p>Dates: 21 January 2020-07 February 2020</p> <p>Symptoms and severity: mild to moderate severity, all suspected patients included</p> <p>Demographics: mean age: cases: 43 years, controls: 34 years gender: % female cases: 45.8%, controls: 41.0%</p> <p>Exposure history: epidemiological exposure history: cases: 69.6%, controls 12.9%</p>
Index tests	<ul style="list-style-type: none"> Fever Headache Rhinnorrhoea Dyspnoea

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Huang 2020 (Continued)

- Wheeze
- Dry cough
- Haemoptysis
- Diarrhoea
- Earache
- Rash
- Enlargement of lymph nodes
- Weakness/fatigue
- Myalgia
- Stuffy nose
- Sore throat
- Chest pain
- Productive cough
- Stomachache
- Nausea/vomiting
- Arthralgia
- Skin ulcer
- Unconsciousness

Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: SARS-CoV-2 infection • RS: RT-PCR (if negative, a second test taken at least 24 h apart), sample type not specified
Flow and timing	RS and index tests both taken on admission
Comparative	
Notes	

Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Unclear		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Unclear		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		Unclear risk	
Are there concerns that the included patients and setting do not match the review question?			Low concern
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes		

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Huang 2020 (Continued)

If a threshold was used, was it pre-specified?	Unclear
Could the conduct or interpretation of the index test have introduced bias?	High risk
Are there concerns that the index test, its conduct, or interpretation differ from the review question?	Low concern
DOMAIN 3: Reference Standard	
Is the reference standards likely to correctly classify the target condition?	Yes
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear
Could the reference standard, its conduct, or its interpretation have introduced bias?	Low risk
Are there concerns that the target condition as defined by the reference standard does not match the question?	Low concern
DOMAIN 4: Flow and Timing	
Was there an appropriate interval between index test and reference standard?	Yes
Did all patients receive the same reference standard?	Yes
Were all patients included in the analysis?	Yes
Could the patient flow have introduced bias?	Low risk

Just 2020

Study characteristics

Patient Sampling

Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); to identify predictive risk factors for a positive SARS-CoV-2 RT-PCR result in a primary care setting

Design: multicentre, cross-sectional cohort study

Recruitment: 26 office-based specialists for internal and/or general medicine with a full primary care mandate from 14 different locations participated in the study. Suspected COVID-19 patients for which a PCR was taken were included.

Sample size: n = 374 (40 cases)

Inclusion criteria: convenience sample of patients who received PCR in the participating GP's practices within the study period

Exclusion criteria: patients whose tests had been carried out for procedural reasons and did not correspond to a specific clinical indication

Just 2020 (Continued)

were excluded (e.g. testing of recovered patients after end of quarantine). There were no other exclusion criteria.

Patient characteristics and setting	<p>Facility cases: suspected patients with a positive PCR test</p> <p>Facility controls: suspected patients with a negative PCR test</p> <p>Country: Germany</p> <p>Dates: 24 March 2020-17 April 2020</p> <p>Symptoms and severity: mild to moderate severity</p> <p>Demographics: median age: cases: 52.0 years, controls: 43.5 years gender: % female cases: 65.0%, controls: 57.2%</p> <p>Exposure history: first grade contact (with symptoms): cases: 35.0%, controls 17.4%</p>		
Index tests	<ul style="list-style-type: none">• Cough• Sore throat• Fatigue• Fever• Nasal congestion• Muscle pain• Dyspnoea• Headache• Anorexia• Anosmia• Diarrhea• Chills• Nausea• Vomiting• Other		
Target condition and reference standard(s)	<ul style="list-style-type: none">• TC: SARS-CoV-2 infection• RS: RT-PCR, sample type not specified		
Flow and timing	RS and index tests both taken on admission		
Comparative			
Notes			
Methodological quality			
Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	No		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Unclear		

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Just 2020 (Continued)

Did the study avoid inappropriate inclusions?	Yes	
Could the selection of patients have introduced bias?		High risk
Are there concerns that the included patients and setting do not match the review question?		Low concern
DOMAIN 2: Index Test (All tests)		
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes	
If a threshold was used, was it pre-specified?	Unclear	
Could the conduct or interpretation of the index test have introduced bias?		High risk
Are there concerns that the index test, its conduct, or interpretation differ from the review question?		Low concern
DOMAIN 3: Reference Standard		
Is the reference standards likely to correctly classify the target condition?	Yes	
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear	
Could the reference standard, its conduct, or its interpretation have introduced bias?		Low risk
Are there concerns that the target condition as defined by the reference standard does not match the question?		Low concern
DOMAIN 4: Flow and Timing		
Was there an appropriate interval between index test and reference standard?	Yes	
Did all patients receive the same reference standard?	Yes	
Were all patients included in the analysis?	Yes	
Could the patient flow have introduced bias?		Low risk

Leal 2020

Study characteristics

Patient Sampling	Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); to describe the clinical features predictive for SARS-CoV-2 infection in primary care Design: prospective population-based cohort
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Leal 2020 (Continued)

Recruitment: residents of the municipality aged ≥ 12 years with suspected COVID-19 symptoms were encouraged to contact the dedicated platform via the website or phone. They were invited to complete an initial screening questionnaire.

Sample size: $n = 1583$ (444 cases (only the PCR-positive patients))

Inclusion criteria: patients meeting the suspected COVID-19 case definition (having at least 2 of the following symptoms: fever, cough, sore throat, coryza or change in/loss of smell (anosmia); or 1 of these symptoms plus at least 2 other symptoms consistent with COVID-19

Exclusion criteria: all pregnant women, and patients meeting pre-defined triage criteria for severe disease

Patient characteristics and setting	<p>Facility cases: patients with suspected COVID-19 who tested positive (RT-PCR, testing at home)</p> <p>Facility controls: patients with suspected COVID-19 who tested negative (RT-PCR, testing at home)</p> <p>Country: Brazil</p> <p>Dates: 13 April 2020-13 May 2020</p> <p>Symptoms and severity: mild to moderate severity, severe cases were excluded</p> <p>Demographics: all age groups represented from ≥ 10 years. Gender: % female cases: 55.0%, controls: 66.5%</p> <p>Exposure history: not specified</p>
Index tests	<ul style="list-style-type: none"> • Headache • Myalgia • Cough • Fatigue • Anosmia • Ageusia
Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: SARS-CoV-2 infection • RS: RT-PCR, some negative patients were offered antibody testing as of 19 May (IgG/IgM combined); self-collected oropharyngeal swabs, collected under supervision of trained healthcare personnel), but results of the antibody testing were not used for this review (only RT-PCR)
Flow and timing	Swabs were taken within 5 days of symptom onset
Comparative	
Notes	

Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			

Leal 2020 (Continued)

Was a consecutive or random sample of patients enrolled?	Yes
Was a case-control design avoided?	Yes
Did the study avoid inappropriate exclusions?	No
Did the study avoid inappropriate inclusions?	Yes
Could the selection of patients have introduced bias?	High risk
Are there concerns that the included patients and setting do not match the review question?	High
DOMAIN 2: Index Test (All tests)	
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes
If a threshold was used, was it pre-specified?	Unclear
Could the conduct or interpretation of the index test have introduced bias?	High risk
Are there concerns that the index test, its conduct, or interpretation differ from the review question?	High
DOMAIN 3: Reference Standard	
Is the reference standards likely to correctly classify the target condition?	Unclear
Were the reference standard results interpreted without knowledge of the results of the index tests?	Yes
Could the reference standard, its conduct, or its interpretation have introduced bias?	Unclear risk
Are there concerns that the target condition as defined by the reference standard does not match the question?	Low concern
DOMAIN 4: Flow and Timing	
Was there an appropriate interval between index test and reference standard?	Yes
Did all patients receive the same reference standard?	No
Were all patients included in the analysis?	Yes
Could the patient flow have introduced bias?	High risk

Lee 2020

Study characteristics

Patient Sampling	<p>Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); to identify symptoms that are specific for SARS-CoV-2 infection</p> <p>Design: nested case-control study (from cross-sectional cohort study, random sampling 1:3)</p> <p>Recruitment: all adults (> 18 years) who underwent COVID-19 tests at an ambulatory assessment centre</p> <p>Sample size: n = 127 (56 cases)</p> <p>Inclusion criteria: adults (\geq 18 years) who had undergone PCR testing and had confirmed results</p> <p>Exclusion criteria: none</p>
Patient characteristics and setting	<p>Facility cases: tested adults with a positive PCR</p> <p>Facility controls: tested adults with a negative PCR</p> <p>Country: Canada</p> <p>Dates: 16 March 2020-15 April 2020</p> <p>Symptoms and severity: mild to moderate severity</p> <p>Demographics: median age: cases: 38.0 years, controls: 43.0 years gender: % female cases: 58.9%, controls: 62.0%</p> <p>Exposure history: not specified</p>
Index tests	<ul style="list-style-type: none"> • Sore throat • Cough • Nasal congestion • Rhinorrhoea • Fever • Shortness of breath • Abdominal pain • Diarrhoea • Anosmia • Hyposmia • Dysgeusia/ageusia • Fatigue • Headache • Other
Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: SARS-CoV-2 infection • RS: RT-PCR, nasopharyngeal swab
Flow and timing	<p>Index tests after RT-PCR (index tests: questions about the presence of smell or taste loss around onset of COVID-19-like symptoms); index tests > 4 weeks since the diagnosis for 67.6% of controls versus 30.4% for cases</p>
Comparative	

Lee 2020 (Continued)

Notes

Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Unclear		
Was a case-control design avoided?	No		
Did the study avoid inappropriate exclusions?	Yes		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		Unclear risk	
Are there concerns that the included patients and setting do not match the review question?			Unclear
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	No		
If a threshold was used, was it pre-specified?	Unclear		
Could the conduct or interpretation of the index test have introduced bias?		High risk	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?			High
DOMAIN 3: Reference Standard			
Is the reference standards likely to correctly classify the target condition?	Yes		
Were the reference standard results interpreted without knowledge of the results of the index tests?	Yes		
Could the reference standard, its conduct, or its interpretation have introduced bias?		Low risk	
Are there concerns that the target condition as defined by the reference standard does not match the question?			Low concern
DOMAIN 4: Flow and Timing			
Was there an appropriate interval between index test and reference standard?	No		
Did all patients receive the same reference standard?	Yes		
Were all patients included in the analysis?	Yes		

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Lee 2020 (Continued)

Could the patient flow have introduced bias?

High risk

Liang 2020

Study characteristics

Patient Sampling

Purpose: to estimate the prevalence of COVID-19 in pneumonias during this period and to find the unique features of COVID-19 as compared to pneumonias caused by other agents

Design: cross-sectional, single-centre, retrospective study

Recruitment: 342 cases of pneumonia were diagnosed in Fever Clinic in Peking University Third Hospital. From these patients, 88 were reviewed by panel discussion as possible or probable cases of COVID-19, and received 2019-nCoV detection by RT-PCR

Sample size: n = 88 (21 cases)

Inclusion criteria: patients visiting the Fever Clinic at Peking University Third Hospital. Based on epidemiological history, epidemiological evidence, fever and/or respiratory symptoms, chest radiological findings and WBC results, cases with possible or probable COVID-19 were sent for panel discussion and then for 2019-nCoV detection by RT-PCR

Exclusion criteria: COVID-19 unlikely by panel discussion; lack of CT scan or no signs of pneumonia on CT scan; paediatric patients

Patient characteristics and setting

Facility cases: 2019-nCoV real-time PCR testing, which was positive in 19 cases (confirmed cases). In another 2 patients, though PCR testing was negative, a clinical diagnosis was made according to epidemiological evidence, consistent clinical and CT findings (clinical cases)

Facility controls: for the cases with negative viral detection, the diagnosis of COVID-19 was excluded based on inconsistent epidemiological, clinical or radiological data

Country: China

Dates: 21 January 2020-15 February 2020

Symptoms

- Fever with a mean body temperature of 37.8 C
- Cough
- Expectoration
- Fatigue
- Headache
- Dizziness
- Shortness of breath
- Myalgia or arthralgia
- Sore throat
- Nasal symptoms and diarrhoea

Severity of COVID-19

- Mild-moderate: fever and/or respiratory symptoms with pneumonia in radiology examination, without signs of severe or very severe diseases
- Severe: presence of 1 of the following: respiratory rate ≥ 30 beat/min; $SpO_2 \leq 93\%$ at rest; $PaO_2/FiO_2 \leq 300$ mmHg
- Very severe: presence of 1 of the following: severe respiratory failure requiring mechanical ventilation; shock; complicated with other organ failure and requiring ICU admission

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Liang 2020 (Continued)

Demographics: COVID-group only: median age was 42.0 years (25th-75th percentile, 34.5-66.0 years). Range 24-85. Male/female: 11 (52.4%)/10 (47.6%)

Exposure history: 19/21 (90.5%) had a clear epidemiological history of COVID-19. 7 patients, from 5 family clusters, had close contact with their family members

Index tests	<ul style="list-style-type: none"> Fever with a mean body temperature of 37.8 C Cough Expectoration Fatigue Headache Dizziness Shortness of breath Myalgia or arthralgia Sore throat Nasal symptoms and diarrhoea
Target condition and reference standard(s)	<ul style="list-style-type: none"> TC: COVID-19 pneumonia RS: 2019-nCoV real-time PCR testing or clinical diagnosis was made according to epidemiological evidence, consistent clinical and CT findings
Flow and timing	Time interval not specified
Comparative	
Notes	

Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Unclear		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	No		
Did the study avoid inappropriate inclusions?	No		
Could the selection of patients have introduced bias?		High risk	
Are there concerns that the included patients and setting do not match the review question?			High
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes		

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Liang 2020 (Continued)

If a threshold was used, was it pre-specified?	No
Could the conduct or interpretation of the index test have introduced bias?	High risk
Are there concerns that the index test, its conduct, or interpretation differ from the review question?	Low concern
DOMAIN 3: Reference Standard	
Is the reference standards likely to correctly classify the target condition?	Yes
Were the reference standard results interpreted without knowledge of the results of the index tests?	No
Could the reference standard, its conduct, or its interpretation have introduced bias?	Low risk
Are there concerns that the target condition as defined by the reference standard does not match the question?	Low concern
DOMAIN 4: Flow and Timing	
Was there an appropriate interval between index test and reference standard?	Unclear
Did all patients receive the same reference standard?	Yes
Were all patients included in the analysis?	Yes
Could the patient flow have introduced bias?	High risk

Mao 2020

Study characteristics

Patient Sampling

Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); to ascertain the effectiveness of the screening strategy and provide insight for early diagnosis of COVID-19

Design: multicentre, retrospective, observational cohort study

Recruitment: all patients visiting the fever clinics within the study period

Mao 2020 (Continued)

	Sample size: n = 1004 (cases = 188) Inclusion criteria: all patients visiting the fever clinics within the study period. Patients with fever (body temperature > 37.5° C), or patients with pulmonary symptoms and epidemiological exposure history were requested to visit the fever clinics. All patients visiting the fever clinics during the study period were included. Exclusion criteria: patients with missing data		
Patient characteristics and setting	Facility cases: RT-PCR-positive patients Facility controls: RT-PCR-negative patients Country: China Dates: 17 January 2020-16 February 2020 Symptoms and severity: not specified Demographics: median age: cases 46 years, controls 39 years female; gender %: cases 50%, controls 47% Exposure history: recent visit to epidemic region: cases 51%, controls 28%; contact with infected person: cases 34%, controls 13%		
Index tests	<ul style="list-style-type: none">• Fever (body temperature >38.5°C)• Chills• Cough• Sore throat• Nasal congestion• Rhinorrhea• Sneezing• Shortness of breath• Haemotysis• Chest pain• Fatigue• Headache• Abdominal pain• Diarrhoea• Nausea/vomiting• Poor appetite• Myalgia		
Target condition and reference standard(s)	<ul style="list-style-type: none">• TC: SARS-CoV-2 infection• RS: RT-PCR (specimen not specified)		
Flow and timing	RS and index tests taken on the same day		
Comparative			
Notes			
Methodological quality			
Item	Authors' judgement	Risk of bias	Applicability concerns

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Mao 2020 (Continued)

DOMAIN 1: Patient Selection

Was a consecutive or random sample of patients enrolled?	Yes
Was a case-control design avoided?	Yes
Did the study avoid inappropriate exclusions?	No
Did the study avoid inappropriate inclusions?	Unclear
Could the selection of patients have introduced bias?	High risk
Are there concerns that the included patients and setting do not match the review question?	Low concern

DOMAIN 2: Index Test (All tests)

Were the index test results interpreted without knowledge of the results of the reference standard?	Yes
If a threshold was used, was it pre-specified?	Unclear
Could the conduct or interpretation of the index test have introduced bias?	High risk
Are there concerns that the index test, its conduct, or interpretation differ from the review question?	Low concern

DOMAIN 3: Reference Standard

Is the reference standards likely to correctly classify the target condition?	Yes
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear
Could the reference standard, its conduct, or its interpretation have introduced bias?	Low risk
Are there concerns that the target condition as defined by the reference standard does not match the question?	Low concern

DOMAIN 4: Flow and Timing

Was there an appropriate interval between index test and reference standard?	Yes
Did all patients receive the same reference standard?	Yes
Were all patients included in the analysis?	Yes
Could the patient flow have introduced bias?	Unclear risk

Nobel 2020

Study characteristics

Patient Sampling	<p>Purpose: assess GI symptoms in COVID-19 and their association with short-term outcomes</p> <p>Design: diagnostic case-control, retrospective study</p> <p>Recruitment: adults who underwent nasopharyngeal swab testing for SARS-CoV-2 at outpatient settings: clinics or the ED, of New York-Presbyterian-Columbia or the medical centre's affiliates in New York</p> <p>Sample size: 516 (278 cases)</p> <p>Inclusion criteria: adults ≥ 18 years of age who underwent nasopharyngeal swab testing for SARS-CoV-2. Indications for testing during this period were respiratory symptoms (cough, fever, shortness of breath) with intent to hospitalise or the same symptoms in essential personnel.</p> <p>Exclusion criteria: if insufficient data were available in the electronic medical record or if testing was performed during a pre-existing inpatient admission</p>
Patient characteristics and setting	<p>Facility cases: SARS-CoV-2 PCR test result positive (1 test)</p> <p>Facility controls: SARS-CoV-2 PCR test result negative</p> <p>Country: USA</p> <p>Dates: 10 March 2020-21 March 2020</p> <p>Symptoms and severity: respiratory symptoms (cough, fever, shortness of breath) with intent to hospitalise or in essential workers</p> <p>Demographics: median age: 51-70 years (cases and controls), gender distribution: cases (M/F(%): 52/48), controls (M/F(%): 45/55)</p> <p>Exposure history: not specified</p>
Index tests	<ul style="list-style-type: none"> GI symptoms: diarrhoea, vomiting/nausea
Target condition and reference standard(s)	<ul style="list-style-type: none"> TC: SARS-CoV-2 infection RS: SARS-CoV-2 RT-PCR test, once (nasopharyngeal swab)
Flow and timing	Time interval: both taken at intake
Comparative	
Notes	

Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	No		

Signs and symptoms to determine if a patient presenting in primary care or hospital outpatient settings has COVID-19 (Review)

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Nobel 2020 (Continued)

Did the study avoid inappropriate exclusions?	Yes	
Did the study avoid inappropriate inclusions?	Yes	
Could the selection of patients have introduced bias?		Low risk
Are there concerns that the included patients and setting do not match the review question?		Low concern
DOMAIN 2: Index Test (All tests)		
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes	
If a threshold was used, was it pre-specified?	No	
Could the conduct or interpretation of the index test have introduced bias?		High risk
Are there concerns that the index test, its conduct, or interpretation differ from the review question?		Low concern
DOMAIN 3: Reference Standard		
Is the reference standards likely to correctly classify the target condition?	Yes	
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear	
Could the reference standard, its conduct, or its interpretation have introduced bias?		Low risk
Are there concerns that the target condition as defined by the reference standard does not match the question?		Low concern
DOMAIN 4: Flow and Timing		
Was there an appropriate interval between index test and reference standard?	Yes	
Did all patients receive the same reference standard?	Yes	
Were all patients included in the analysis?	Yes	
Could the patient flow have introduced bias?		Low risk

O'Reilly 2020

Study characteristics		
Patient Sampling	Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); to determine the clinical and epidemiological predictors of a positive SARS-CoV-2 test result and the requirement for intensive respiratory support	

Signs and symptoms to determine if a patient presenting in primary care or hospital outpatient settings has COVID-19 (Review)

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O'Reilly 2020 (Continued)

Design: prospective cohort study

Recruitment: adult patients who meet testing criteria for COVID-19 and have a SARS-CoV-2 PCR test requested in the ED

Sample size: n = 240 (cases = 11)

Inclusion criteria: all adults who met the testing criteria for COVID-19 and who presented at the ED

Exclusion criteria: patients who attended the screening clinic and did not present for medical assessment in the ED (no clinical data available)

Patient characteristics and setting

Facility cases: positive RT-PCR for SARS-CoV-2

Facility controls: negative RT-PCR for SARS-CoV-2

Country: Australia

Dates: 01 April 2020-14 April 2020

Symptoms and severity: moderate to severe

Demographics: mean age: cases 51, controls 61 female gender %: cases 28%, controls 45%

Exposure history: contact with infected person: cases 56%, controls 7%

Index tests

- Shortness of breath
- Cough
- Change to chronic cough
- Anosmia/dysgeusia
- Sore throat
- Runny nose
- Fever
- Fatigue
- Myalgia
- Diarrhoea

Target condition and reference standard(s)

- TC: SARS-CoV-2 infection
- RS: SARS-CoV-2 RT-PCR test (specimen not specified)

Flow and timing

RS and index tests taken on the same day

Comparative

Notes

Methodological quality

Item

Authors' judgement

Risk of bias

Applicability concerns

DOMAIN 1: Patient Selection

Was a consecutive or random sample of patients enrolled?

Yes

O'Reilly 2020 (Continued)

Was a case-control design avoided?	Yes	
Did the study avoid inappropriate exclusions?	Unclear	
Did the study avoid inappropriate inclusions?	Yes	
Could the selection of patients have introduced bias?		Low risk
Are there concerns that the included patients and setting do not match the review question?		Low concern
DOMAIN 2: Index Test (All tests)		
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes	
If a threshold was used, was it pre-specified?	No	
Could the conduct or interpretation of the index test have introduced bias?		High risk
Are there concerns that the index test, its conduct, or interpretation differ from the review question?		Low concern
DOMAIN 3: Reference Standard		
Is the reference standards likely to correctly classify the target condition?	Yes	
Were the reference standard results interpreted without knowledge of the results of the index tests?	Yes	
Could the reference standard, its conduct, or its interpretation have introduced bias?		Low risk
Are there concerns that the target condition as defined by the reference standard does not match the question?		Low concern
DOMAIN 4: Flow and Timing		
Was there an appropriate interval between index test and reference standard?	Yes	
Did all patients receive the same reference standard?	Yes	
Were all patients included in the analysis?	Yes	
Could the patient flow have introduced bias?		Low risk

Peng 2020**Study characteristics**

Patient Sampling	Purpose: analyse the clinical features and imaging manifestations of COVID-19
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Peng 2020 (Continued)

	<p>Design: cross-sectional, single-centre, retrospective study</p> <p>Recruitment: clinically suspected cases who were sent to hospital for screening</p> <p>Sample size: n = 86 (n = 11)</p> <p>Inclusion criteria: clinically suspected patients</p> <p>Exclusion criteria: not specified</p>		
Patient characteristics and setting	<p>Facility cases: positive RT-PCR via nasopharyngeal swab</p> <p>Facility controls: negative RT-PCR via nasopharyngeal swab (once)</p> <p>Country: China</p> <p>Dates: 23 January 2020-16 February 2020</p> <p>Symptoms and severity: fever, cough, dyspnoea, sore throat, fatigue, systemic soreness, runny nose</p> <p>Demographics: M/F: total 39/47, cases: 5/6, controls 34/40</p> <p>Case group: mean age 40.73 ± 11.32 years, 5 men. Control group: mean age 39.67 ± 13.90 years, 34 men</p> <p>Exposure history: 7/11 COVID-19 patients (63.6%) had a history of travel to Hubei (5 Wuhan, 1 Huanggang, 1 Xiaogan), 2 patients had close contact with the COVID-19 patients, and 2 taxi drivers</p>		
Index tests	<ul style="list-style-type: none">• Fever• Cough• Dyspnoea• Sore throat• Fatigue• Systemic soreness• Runny nose		
Target condition and reference standard(s)	<ul style="list-style-type: none">• TC: SARS-CoV-2 infection• RS: RT-PCR (nasopharyngeal swab)		
Flow and timing	Time interval not specified		
Comparative			
Notes			
Methodological quality			
Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Unclear		
Was a case-control design avoided?	Yes		

Peng 2020 (Continued)

Did the study avoid inappropriate exclusions?	Unclear
Did the study avoid inappropriate inclusions?	Unclear
Could the selection of patients have introduced bias?	Unclear risk
Are there concerns that the included patients and setting do not match the review question?	Unclear
DOMAIN 2: Index Test (All tests)	
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes
If a threshold was used, was it pre-specified?	No
Could the conduct or interpretation of the index test have introduced bias?	High risk
Are there concerns that the index test, its conduct, or interpretation differ from the review question?	Low concern
DOMAIN 3: Reference Standard	
Is the reference standards likely to correctly classify the target condition?	Yes
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear
Could the reference standard, its conduct, or its interpretation have introduced bias?	Low risk
Are there concerns that the target condition as defined by the reference standard does not match the question?	Low concern
DOMAIN 4: Flow and Timing	
Was there an appropriate interval between index test and reference standard?	Unclear
Did all patients receive the same reference standard?	Yes
Were all patients included in the analysis?	Yes
Could the patient flow have introduced bias?	Low risk

Peyrony 2020

Study characteristics	
Patient Sampling	Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); to assess utility of clinical parameters, physician clinical judgment, and lung ultrasonography to accurately identify SARS-CoV-2 infected patients at ED presentation

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Peyrony 2020 (Continued)

Design: prospective cohort study

Recruitment: cohort of all adult (≥ 18 years) patients with suspected COVID-19 who were tested for SARS-CoV-2 prospectively enrolled at university ED (not every patient was tested for SARS-CoV-2: testing was left to the clinician's discretion)

Sample size: n = 391 (225 cases)

Inclusion criteria: no predefined inclusion criteria. Testing was mostly performed in patients who had severe symptoms such as dyspnoea, reported shortness of breath, presented with comorbidities, or were > 70 years. Some patients without COVID-19 symptoms were also tested when they needed admission to hospital.

Exclusion criteria: patients who attended the ED more than once (only the last visit was included). There were no other exclusion criteria.

Patient characteristics and setting	<p>Facility cases: all patients who tested positive for SARS-CoV-2 by RT-PCR</p> <p>Facility controls: all patients who tested negative for SARS-CoV-2 by RT-PCR</p> <p>Country: France</p> <p>Dates: 09 March 2020-04 April 2020</p> <p>Symptoms and severity: moderate to mild severity, inclusion based on signs and symptoms suggestive of SARS-CoV-2 infection, 82% of included patients with comorbidities; not all included patients had COVID-19 symptoms</p> <p>Demographics: all included patients (pos + neg): median age: 62 years % female: 38.4%</p> <p>Exposure history: not specified</p>
Index tests	<ul style="list-style-type: none"> • Fever • Cough • Dyspnoea • Myalgia • Rhinitis/pharyngitis • Anosmia • Headache • Gastrointestinal symptoms • Fatigue • Chest pain • Dizziness/syncope • Haemoptysis • oxygen saturation
Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: SARS-CoV-2 infection • RS: RT-PCR for SARS-CoV-2 (negatives re-tested after 48 h), nasal swab
Flow and timing	RS and index tests both taken at presentation
Comparative	
Notes	

Methodological quality

Signs and symptoms to determine if a patient presenting in primary care or hospital outpatient settings has COVID-19 (Review)

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Peyrony 2020 (Continued)

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Yes		
Did the study avoid inappropriate inclusions?	No		
Could the selection of patients have introduced bias?		Unclear risk	
Are there concerns that the included patients and setting do not match the review question?			Unclear
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes		
If a threshold was used, was it pre-specified?	No		
Could the conduct or interpretation of the index test have introduced bias?		High risk	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?			Low concern
DOMAIN 3: Reference Standard			
Is the reference standards likely to correctly classify the target condition?	Yes		
Were the reference standard results interpreted without knowledge of the results of the index tests?	Yes		
Could the reference standard, its conduct, or its interpretation have introduced bias?		Low risk	
Are there concerns that the target condition as defined by the reference standard does not match the question?			Low concern
DOMAIN 4: Flow and Timing			
Was there an appropriate interval between index test and reference standard?	Yes		
Did all patients receive the same reference standard?	Yes		
Were all patients included in the analysis?	Yes		

Signs and symptoms to determine if a patient presenting in primary care or hospital outpatient settings has COVID-19 (Review)

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Peyrony 2020 (Continued)

Could the patient flow have introduced bias?

Low risk

Pisapia 2020

Study characteristics

Patient Sampling	<p>Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); to compare the characteristics at hospital admission of confirmed and not-confirmed COVID-19 patients, in the early phase of the epidemic</p> <p>Design: retrospective cohort study</p> <p>Recruitment: all patients consecutively admitted in selected medical wards (ED + lab) of the mono-specialist infectious diseases referral centre because of clinical suspicion of COVID-19</p> <p>Sample size: n = 37 (17 cases)</p> <p>Inclusion criteria: all patients consecutively admitted in the selected medical wards because of clinical suspicion of COVID-19. No specification of 'suspicion'</p> <p>Exclusion criteria: none</p>
Patient characteristics and setting	<p>Facility cases: suspected cases with a positive RT-PCR (second test after 24 h if first negative)</p> <p>Facility controls: suspected cases with a negative RT-PCR (2 negative tests)</p> <p>Country: Italy</p> <p>Dates: 10 February 2020-10 March 2020</p> <p>Symptoms and severity: mild to moderate severity</p> <p>Demographics: median age cases: 49 years controls: 29 years. Gender: % female cases: 35%, controls: 35%</p> <p>Exposure history: travel to affected area: cases 35%, controls 95% contact with a confirmed case: cases 47%, controls: 0% contact with persons from affected area: cases: 12% controls: 0%</p>
Index tests	<ul style="list-style-type: none"> • Fever • Cough • Dyspnea • Arthralgia • Conjunctivitis • Other
Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: SARS-CoV-2 infection • RS: RT-PCR, different tests used: targeted to different genomic region (regions RdRp, N and E) (commercial kits used during study changed), negatives re-tested after 24 h, nasopharyngeal swab
Flow and timing	RS and index tests both taken on admission
Comparative	

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Pisapia 2020 (Continued)

Notes

Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Yes		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		Low risk	
Are there concerns that the included patients and setting do not match the review question?			Low concern
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes		
If a threshold was used, was it pre-specified?	Unclear		
Could the conduct or interpretation of the index test have introduced bias?		High risk	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?			Low concern
DOMAIN 3: Reference Standard			
Is the reference standards likely to correctly classify the target condition?	Yes		
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear		
Could the reference standard, its conduct, or its interpretation have introduced bias?		Low risk	
Are there concerns that the target condition as defined by the reference standard does not match the question?			Low concern
DOMAIN 4: Flow and Timing			
Was there an appropriate interval between index test and reference standard?	Yes		
Did all patients receive the same reference standard?	No		

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Pisapia 2020 (Continued)

Were all patients included in the analysis?	Yes
Could the patient flow have introduced bias?	Unclear risk

Rentsch 2020

Study characteristics	
Patient Sampling	<p>Purpose: diagnosis SARS-CoV-2 test positives</p> <p>Design: cross-sectional, retrospective study</p> <p>Recruitment: electronic health record data from the national Veterans Affairs Healthcare System - national Corporate Data Warehouse (USA)</p> <p>Sample size: 3789 (585 cases)</p> <p>Inclusion criteria: all patients in the Veterans Affairs cohort, born between 1945 and 1965 and active in care, tested for COVID-19 between 8 February and 30 March 2020</p> <p>Exclusion criteria: patients for whom results were pending (n = 93) or inconclusive (n = 33) were excluded</p>
Patient characteristics and setting	<p>Facility cases: tested positive for SARS-CoV-2</p> <p>Facility controls: tested negative for SARS-CoV-2</p> <p>Country: USA</p> <p>Dates: 8 February 2020-30 March 2020</p> <p>Symptoms and severity: all patients who were tested were included</p> <p>Demographics: median age overall: 65.7 years (IQR 60.5-70.7) (cases: 66.1 years, controls: 65.6 years);</p> <p>gender overall (M%/F%): 90.2/9.8, cases 95.4/4.6, controls 89.2/10.8</p> <p>Exposure history: not specified (all over USA)</p>
Index tests	<ul style="list-style-type: none"> Hypoxia (oxygen saturation $\leq 93\%$) Body temperature (3 categories: $\leq 98.6^\circ\text{F}$, $98.7\text{-}100.3^\circ\text{F}$, $\geq 100.4^\circ\text{F}$)
Target condition and reference standard(s)	<ul style="list-style-type: none"> TC: SARS-CoV-2 infection RS: no data on which reference PCR test used, multiple different reference tests used with unknown test characteristics (samples: nasopharyngeal swabs)
Flow and timing	Time interval maximum 2 days
Comparative	
Notes	
Methodological quality	

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Rentsch 2020 (Continued)

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Yes		
Did the study avoid inappropriate inclusions?	Unclear		
Could the selection of patients have introduced bias?		Low risk	
Are there concerns that the included patients and setting do not match the review question?			Unclear
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Unclear		
If a threshold was used, was it pre-specified?	Yes		
Could the conduct or interpretation of the index test have introduced bias?		Unclear risk	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?			Low concern
DOMAIN 3: Reference Standard			
Is the reference standards likely to correctly classify the target condition?	Unclear		
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear		
Could the reference standard, its conduct, or its interpretation have introduced bias?		Unclear risk	
Are there concerns that the target condition as defined by the reference standard does not match the question?			Low concern
DOMAIN 4: Flow and Timing			
Was there an appropriate interval between index test and reference standard?	Yes		
Did all patients receive the same reference standard?	Unclear		
Were all patients included in the analysis?	No		
Could the patient flow have introduced bias?		Low risk	

Salmon 2020

Study characteristics

Patient Sampling	<p>Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); second part of the study: to assess the diagnostic accuracy of olfactory/gustatory dysfunction for SARS-CoV-2 infection in the overall population tested for SARS-CoV-2</p> <p>Design: prospective cohort study</p> <p>Recruitment: all consecutive patients who were tested for SARS-CoV-2 in the Paris-based screening centre for COVID-19</p> <p>Sample size: n = 1824 (849 cases)</p> <p>Inclusion criteria: (second part of the study): all consecutive patients with a suspicion of SARS-CoV-2 infection, independent of loss of smell no specification of 'suspicion'</p> <p>Exclusion criteria: (second part of the study): none</p>		
Patient characteristics and setting	<p>Facility cases: all suspected patients with a positive RT-PCR</p> <p>Facility controls: all suspected patients with a negative RT-PCR</p> <p>Country: France</p> <p>Dates: 17 March 2020-25 March 2020</p> <p>Symptoms and severity: mild to moderate severity</p> <p>Demographics: not specified for second part of this study</p> <p>Exposure history: not specified</p>		
Index tests	<ul style="list-style-type: none">Self-reported loss of smell and/or taste: loss of smell only, loss of taste only, loss of smell and taste, loss of smell and/or loss of tasteCoughHeadacheSore throat		
Target condition and reference standard(s)	<ul style="list-style-type: none">TC: SARS-CoV-2 infectionRS: RT-PCR test, nasopharyngeal swabs		
Flow and timing	RS and index tests both taken at presentation		
Comparative			
Notes			
Methodological quality			
Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		

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Salmon 2020 (Continued)

Was a case-control design avoided?	Yes	
Did the study avoid inappropriate exclusions?	Yes	
Did the study avoid inappropriate inclusions?	Yes	
Could the selection of patients have introduced bias?		Low risk
Are there concerns that the included patients and setting do not match the review question?		Low concern
DOMAIN 2: Index Test (All tests)		
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes	
If a threshold was used, was it pre-specified?	Unclear	
Could the conduct or interpretation of the index test have introduced bias?		High risk
Are there concerns that the index test, its conduct, or interpretation differ from the review question?		Low concern
DOMAIN 3: Reference Standard		
Is the reference standards likely to correctly classify the target condition?	Yes	
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear	
Could the reference standard, its conduct, or its interpretation have introduced bias?		Low risk
Are there concerns that the target condition as defined by the reference standard does not match the question?		Low concern
DOMAIN 4: Flow and Timing		
Was there an appropriate interval between index test and reference standard?	Yes	
Did all patients receive the same reference standard?	Yes	
Were all patients included in the analysis?	Yes	
Could the patient flow have introduced bias?		Low risk

Shah 2020

Study characteristics

Patient Sampling

Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); to describe characteristics, diagnostics and outcomes of patients with

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Shah 2020 (Continued)

	<p>respiratory illness, comparing patients with and without COVID-19 disease</p> <p>Design: retrospective cohort</p> <p>Recruitment: all patients presenting to an ED with an acute respiratory illness and tested for SARS-CoV-2</p> <p>Sample size: n = 316 (33 cases)</p> <p>Inclusion criteria: all patients ≥ 18 years who underwent testing for COVID-19 within 24 h of presentation to the ED. Patients with acute respiratory symptoms, influenza-like illness</p> <p>Exclusion criteria: not specified</p>
Patient characteristics and setting	<p>Facility cases: positive RT-PCR for SARS-CoV-2</p> <p>Facility controls: negative RT-PCR for SARS-CoV-2</p> <p>Country: California, USA</p> <p>Dates: 03 February 2020-31 March 2020</p> <p>Symptoms and severity: not specified</p> <p>Demographics: median age: cases 63, controls 62. % female: cases 36%, controls 50%</p> <p>Exposure history: travel in last 21 days or known COVID exposure: cases 46%, controls 11%</p>
Index tests	<ul style="list-style-type: none"> • Fever (patient reported) • Fatigue/malaise • Cough (dry, productive) • Myalgia • Dyspnoea • Chest pain • Sore throat • Nasal congestion/rhinorrhoea • Diarrhoea • Nausea • Vomiting • Abdominal pain • Headache • Altered mentation • Tachycardia (> 100 beats/min) • Low mean arterial pressure (< 60 mmHg) • Tachypnea (respiratory rate > 20 breaths/min) • Fever
Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: SARS-CoV-2 infection • RS: RT-PCR test, oropharyngeal and/or nasopharyngeal swabs
Flow and timing	RS performed maximum 24 h later than index tests
Comparative	

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Shah 2020 (Continued)

Notes

Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Yes		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		Low risk	
Are there concerns that the included patients and setting do not match the review question?			Low concern
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes		
If a threshold was used, was it pre-specified?	Yes		
Could the conduct or interpretation of the index test have introduced bias?		High risk	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?			Low concern
DOMAIN 3: Reference Standard			
Is the reference standards likely to correctly classify the target condition?	Yes		
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear		
Could the reference standard, its conduct, or its interpretation have introduced bias?		Unclear risk	
Are there concerns that the target condition as defined by the reference standard does not match the question?			Low concern
DOMAIN 4: Flow and Timing			
Was there an appropriate interval between index test and reference standard?	Yes		
Did all patients receive the same reference standard?	Yes		
Were all patients included in the analysis?	Yes		

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Shah 2020 (Continued)

Could the patient flow have introduced bias?

Low risk

Song 2020a

Study characteristics

Patient Sampling

Purpose: to develop a tool for early diagnosis of SARS-CoV-2-infected patients

Design: cross-sectional, retrospective, single-centre (2 time frame study: training - validation data set)

Recruitment: 1311 patients who presented to the First Affiliated Hospital, School of Medicine, Zhejiang University with at least 1 SARS-CoV-2 RT-PCR test

Sample size: n = 304 (73 cases) (= subset of the study including training dataset only)
n = 95 (18 cases) (= validation dataset)

Inclusion criteria

- All RT-PCR-positive cases; 1311
- All RT-PCR-negative patients who came to the First Affiliated Hospital, School of Medicine, Zhejiang University and performed with at least 1 SARS-CoV-2 nucleic acid detection for analysis RT-PCR
- First 60% of negative outpatients sorted by 'Z-A' based on Chinese first name from Qingchun District (training dataset), and then final 40% who presented (validation dataset)

Exclusion criteria

- Asymptomatic patients without history of exposure but had strong willingness for detection
- Patients with "important" missing data

Patient characteristics and setting

Facility cases: positive SARS-CoV-2

Facility controls: negative SARS-CoV-2

Country: China

Dates: 20 January 2020-05 February 2020

Symptoms and severity: in positives: non-severe (n = 31), including mild or moderate patients to severe (n = 42) including severe or critical patients

- Mild: patients had no pneumonia on imaging (CT)
- Moderate: patients with symptoms and imaging examination showing pneumonia
- Severe: patients meet any of the following:
 - * respiratory rate $\geq 30/\text{min}$
 - * resting pulse $\text{SpO}_2 \leq 93\%$
 - * $\text{PaO}_2/\text{FiO}_2 \leq 300 \text{ mmHg}$ (1 mmHg = 0.133 kPa)
 - * multiple pulmonary lobes showing > 50% progression of lesion in 24-48 h on imaging
- Critical: patients meet any of the following:
 - * respiratory failure requiring mechanical ventilation
 - * shock
 - * combination of other organ failure that requires admission to ICU

Song 2020a (Continued)

Demographics: M/F: cases 46/27, controls 104/127
median age: cases 53.0 years (43.5-62.0) controls 34 years (29-49)

Exposure history: Wuhan-related exposure and or close contact to confirmed COVID-19 case: cases 40.7%, controls 57.5%

Index tests	<ul style="list-style-type: none"> • Fever • Cough • Expectoration • Headache • Myalgia or fatigue • Chill • Rhinobyon/rhinorrhoea • Pharyngalgia • Dyspnoea • Diarrhoea • Nausea/vomiting • Temperature (maximum) • Body temperature • SpO₂ • Respiratory rate • Heart rate • Mean arterial pressure
Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: SARS-CoV-2 infection • RS: RT-PCR for SARS-CoV-2 (test not specified: "using emergency use authorization approved SARS-CoV-2 assays)" (following WHO protocol, 2 target RT-PCR (ORF1 and N))
Flow and timing	Within 3 h for RS, first in-hospital stay for index tests
Comparative	
Notes	

Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	No		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Unclear		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		Unclear risk	

Song 2020a (Continued)

Are there concerns that the included patients and setting do not match the review question?		Low concern
DOMAIN 2: Index Test (All tests)		
Were the index test results interpreted without knowledge of the results of the reference standard?	Unclear	
If a threshold was used, was it pre-specified?	No	
Could the conduct or interpretation of the index test have introduced bias?	High risk	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?		Low concern
DOMAIN 3: Reference Standard		
Is the reference standards likely to correctly classify the target condition?	Yes	
Were the reference standard results interpreted without knowledge of the results of the index tests?	Yes	
Could the reference standard, its conduct, or its interpretation have introduced bias?	Low risk	
Are there concerns that the target condition as defined by the reference standard does not match the question?		Low concern
DOMAIN 4: Flow and Timing		
Was there an appropriate interval between index test and reference standard?	Yes	
Did all patients receive the same reference standard?	Yes	
Were all patients included in the analysis?	Yes	
Could the patient flow have introduced bias?	Low risk	

Sun 2020

Study characteristics		
Patient Sampling	Purpose: algorithm development for estimating risk of COVID-19	

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Sun 2020 (Continued)

Design: cross-sectional, retrospective study

Recruitment: patients presenting at the designated national outbreak screening centre and tertiary care hospital in Singapore for SARS-CoV-2 testing. Patients were either self-referred, referred from primary care facilities, or were at-risk cases identified by national contact tracing efforts (recruited n = 991)

Sample size: n = 788 (n = 54)

Inclusion criteria: patients presenting to the centre:

- self-referred
- referred from primary care facilities
- at-risk cases identified by national contact tracing efforts

Exclusion criteria: PCR results not available at time of data collection - no electronic medical records - unavailable vital sign records

Patient characteristics and setting

Facility cases: positive SARS-CoV-2 RT-PCR test

Facility controls: all SARS-CoV-2 RT-PCR results were negative (minimum 2 test negatives in high-risk patients, minimum 1 test low-risk patients)

Country: Singapore

Dates: 26 January 2020-16 February 2020

Symptoms and severity: 252 (33.2%) symptoms > 5 days at presentation, 75 (9.5%) any comorbidity

- Body temperature
- Heart rate
- Respiratory rate
- Systolic BP
- Diastolic BP
- Cough
- Sputum production
- Shortness of breath
- Rhinorrhoea or nasal congestion
- Sore throat
- Auscultation finding of pneumonia
- Other respiratory symptoms
- Gastrointestinal symptoms

Demographics: median age 34 years (range 7 years-98 years, IQR 27-45) (cases median 42 years, range 16-79; controls 34 years (range 7-98); M/F: 48.3%/51.7% F (cases M: 88 (88.9%))

Exposure history: contact with a known COVID-19 case (20.1% (32/54 cases (59.3%)); 126/734 controls (17.2%)), contact with travellers from China (22.1%, 15/54 cases (27.8%); 42/734 controls (5.7%)), recent travel history, and visit to hospital in China within 14 days prior to symptom onset (0.8%)

Index tests

- Body temperature
- Heart rate
- Respiratory rate
- Systolic BP
- Diastolic BP
- Cough

Sun 2020 (Continued)

- Sputum production
- Shortness of breath
- Rhinorrhea or nasal congestion
- Sore throat
- Auscultation finding of pneumonia
- Other respiratory symptoms
- GI symptoms

Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: SARS-CoV-2 infection • RS: SARS-CoV-2 2 commercial assays 2-target (1 assay: Orf1ab and N - other unclear) RT-PCR
Flow and timing	Time interval not specified
Comparative	
Notes	

Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	No		
Did the study avoid inappropriate exclusions?	Yes		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		High risk	
Are there concerns that the included patients and setting do not match the review question?			High
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes		
If a threshold was used, was it pre-specified?	No		
Could the conduct or interpretation of the index test have introduced bias?		High risk	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?			Low concern
DOMAIN 3: Reference Standard			

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Sun 2020 (Continued)

Is the reference standards likely to correctly classify the target condition?	Yes
Were the reference standard results interpreted without knowledge of the results of the index tests?	No
Could the reference standard, its conduct, or its interpretation have introduced bias?	Low risk
Are there concerns that the target condition as defined by the reference standard does not match the question?	Low concern
DOMAIN 4: Flow and Timing	
Was there an appropriate interval between index test and reference standard?	Unclear
Did all patients receive the same reference standard?	Yes
Were all patients included in the analysis?	Yes
Could the patient flow have introduced bias?	Low risk

Tolia 2020

Study characteristics	
Patient Sampling	<p>Purpose: diagnosis of acute SARS-CoV-2 infection</p> <p>Design: cross-sectional, retrospective study</p> <p>Recruitment: all patients presenting to 1 of 2 EDs, located at an urban teaching hospital, and academic quaternary medical centre, within the same healthcare system who had targeted testing based on clinician's decision during the initial 10 days of test availability</p> <p>Sample size: n = 283 (29 cases)</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> patients presenting with symptoms related to COVID-19 infection (fever and cough or shortness of breath) travel within 14 days to countries with high rates of infection (at that time China, Iran, Italy, Japan, and South Korea) or risk factors for infection complications (including age or comorbid conditions) or the patient was a healthcare worker who could potentially expose others at risk and clinician made decision for testing <p>Exclusion criteria: not specified</p>
Patient characteristics and setting	<p>Facility cases: positive SARS-CoV-2 test</p> <p>Facility controls: negative SARS-CoV-2 test, visiting the same EDs and being tested</p>

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Tolia 2020 (Continued)

Country: USA (San Diego, CA)

Dates: 10 March 2020-19 March 2020

Symptoms and severity:

- all patients presenting to ED who were eligible for targeted testing (= patients presenting with symptoms related to COVID-19 infection (fever and cough or shortness of breath))
- travel within 14 days to countries with high rates of infection (at that time China, Iran, Italy, Japan, and South Korea) or
- risk factors for infection complications (including age or comorbid conditions) or
- the patient was a healthcare worker who could potentially expose others at risk
- comorbidities 101/235 (43.0%) (cases: 8/27 (29.6%), controls 93/208 (44.7%))

Demographics: age (< 18 years: 0.7%, 18-64 years: 83.4%, > 65 years: 15.9%); gender: cases M/F%: 55.2/44.8; controls M/F%: 52.8/47.2; all M/F%: 53.0/47.0

Exposure history: recent travel (5.5%), 90.6% symptom-based criteria for testing, no known exposure history based

Index tests	<ul style="list-style-type: none"> • Fever
Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: SARS-CoV-2 infection • RS: commercial RT-PCR test - ePLEX SARS-CoV-2 test (nasopharyngeal swab)
Flow and timing	Probably no time interval between index test and RS, but not specified
Comparative	
Notes	

Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Unclear		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		Unclear risk	
Are there concerns that the included patients and setting do not match the review question?			Low concern
DOMAIN 2: Index Test (All tests)			

Tolia 2020 (Continued)

Were the index test results interpreted without knowledge of the results of the reference standard?	Yes	
If a threshold was used, was it pre-specified?	No	
Could the conduct or interpretation of the index test have introduced bias?		High risk
Are there concerns that the index test, its conduct, or interpretation differ from the review question?		Low concern
DOMAIN 3: Reference Standard		
Is the reference standards likely to correctly classify the target condition?	Yes	
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear	
Could the reference standard, its conduct, or its interpretation have introduced bias?		Unclear risk
Are there concerns that the target condition as defined by the reference standard does not match the question?		Low concern
DOMAIN 4: Flow and Timing		
Was there an appropriate interval between index test and reference standard?	Unclear	
Did all patients receive the same reference standard?	Yes	
Were all patients included in the analysis?	Yes	
Could the patient flow have introduced bias?		Low risk

Tordjman 2020

Study characteristics

Patient Sampling

Purpose: diagnosis of COVID-19 pneumonia; to determine the independent variables associated with SARS-CoV-2 infection

Design: retrospective observational study

Recruitment: a retrospective cohort of 100 patients with both RT-PCR and CT-scan results available with a 1:1 patient:control inclusion ratio from ED at Cochin Hospital (Paris, France) with a suspicion of SARS-CoV-2 infection: 50 consecutive infected patients and 50 consecutive controls (+ validation cohort)

Tordjman 2020 (Continued)

Sample size: n = 100 (50 cases) (no clinical data available from validation cohort)

Inclusion criteria: suspicion of SARS-CoV-2 infection, and both RT-PCR and CT-scan available 'suspicion' not defined

Exclusion criteria: absence of confirmed diagnosis (diagnosis still under investigation; N = 4); lack of blood test including complete white blood cell count and serum electrolytes (N = 6); absence of reported clinical characteristics (N = 2)

Patient characteristics and setting

Facility cases: suspected patients with a positive RT-PCR or positive CT-scan (positive signs of COVID-19 pneumonia: usually bilateral and peripheral ground-glass and consolidated pulmonary opacities)

Facility controls: suspected patients with a negative RT-PCR and negative findings on CT-scan

Country: France

Dates: 15 March 2020-05 April 2020

Symptoms and severity: not specified

Demographics: median age: cases 60.8 years, controls 54.1 years. Female %: cases 40%, controls 50%

Exposure history: not specified

Index tests

- Cough
- Fever
- Shortness of breath
- Diarrhoea
- Myalgia
- Headache
- Anosmia
- Ageusia

Target condition and reference standard(s)

- TC: COVID-19 pneumonia
- RS: RT-PCR (specimen not specified) or CT-scan lungs

Flow and timing

RS and index tests both taken at first presentation

Comparative

Notes

Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	Yes		

Tordjman 2020 (Continued)

Did the study avoid inappropriate exclusions?	Yes	
Did the study avoid inappropriate inclusions?	Yes	
Could the selection of patients have introduced bias?		Low risk
Are there concerns that the included patients and setting do not match the review question?		Low concern
DOMAIN 2: Index Test (All tests)		
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes	
If a threshold was used, was it pre-specified?	Unclear	
Could the conduct or interpretation of the index test have introduced bias?		High risk
Are there concerns that the index test, its conduct, or interpretation differ from the review question?		Low concern
DOMAIN 3: Reference Standard		
Is the reference standards likely to correctly classify the target condition?	Yes	
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear	
Could the reference standard, its conduct, or its interpretation have introduced bias?		Unclear risk
Are there concerns that the target condition as defined by the reference standard does not match the question?		Low concern
DOMAIN 4: Flow and Timing		
Was there an appropriate interval between index test and reference standard?	Yes	
Did all patients receive the same reference standard?	Unclear	
Were all patients included in the analysis?	Yes	
Could the patient flow have introduced bias?		Unclear risk

Trubiano 2020

Study characteristics

Patient Sampling **Purpose:** diagnosis of SARS-CoV-2 infection (mild COVID-19 disease)

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Trubiano 2020 (Continued)

Design: prospective cohort study

Recruitment: data on all patients presenting at a COVID-19 rapid assessment screening clinic were prospectively collected in an electronic database. Only those patients that met the DHHS (Victorian Department of Health and Human Services) criteria for SARS-CoV-2 testing had nasopharyngeal swab collected for SARS-CoV-2 nucleic acid detection by PCR

Sample size: n = 2935 (108 cases)

Inclusion criteria: all people meeting DHHS criteria for testing: Fever or chills in the absence of an alternative diagnosis that explains the clinical presentation or acute respiratory infection symptoms (e.g. cough, sore throat, shortness of breath, runny nose, loss of smell or loss of taste)

Exclusion criteria: pending or intermediate results

Patient characteristics and setting

Facility cases: patients with suspected COVID-19 with a positive RT-PCR for SARS-CoV-2

Facility controls: suspected patients with a negative RT-PCR for SARS-CoV-2

Country: Australia

Dates: 11 March 2020-22 April 2020

Symptoms and severity: mild to moderate severity

Demographics: median age: cases 51 years, controls 38 years. Female%: cases 49.1%, controls 64.1%

Exposure history: overseas health facility exposure: cases 1.9%, controls 4.0%. Australian health facility exposure: cases 11.1%, controls 31.5%. Contact with known COVID-19-positive patient: cases 57.4%, controls 15.8%

Index tests

- Any fever
- Fever >38°C
- Subjective fever
- Sore throat
- Cough
- Shortness of breath
- Chest pain
- Anosmia
- Ageusia
- Anosmia or ageusia
- Coryza
- Diarrhoea
- Other GI symptoms
- Malaise/myalgia/arthritis
- Headache

Target condition and reference standard(s)

- TC: SARS-CoV-2 infection
- RS: RT-PCR (nasopharyngeal swab)

Flow and timing

RS and index tests both taken at presentation

Comparative

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Trubiano 2020 (Continued)

Notes

Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Yes		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		Low risk	
Are there concerns that the included patients and setting do not match the review question?			Low concern
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes		
If a threshold was used, was it pre-specified?	Unclear		
Could the conduct or interpretation of the index test have introduced bias?		High risk	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?			Low concern
DOMAIN 3: Reference Standard			
Is the reference standards likely to correctly classify the target condition?	Yes		
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear		
Could the reference standard, its conduct, or its interpretation have introduced bias?		Low risk	
Are there concerns that the target condition as defined by the reference standard does not match the question?			Low concern
DOMAIN 4: Flow and Timing			
Was there an appropriate interval between index test and reference standard?	Yes		

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Trubiano 2020 (Continued)

Did all patients receive the same reference standard?	Yes
Were all patients included in the analysis?	Yes
Could the patient flow have introduced bias?	Low risk

Tudrej 2020

Study characteristics

Patient Sampling	<p>Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); to diagnose SARS-CoV-2 infection in primary care settings based on signs and symptoms</p> <p>Design: cross-sectional prospective cohort study</p> <p>Recruitment: recruitment in 2 clinical laboratories in Lyon (France) to which GPs refer patients with suspected COVID-19 for a nasopharyngeal smear (RT-PCR)</p> <p>Sample size: n = 816 (198 cases)</p> <p>Inclusion criteria: all consecutive patients referred by GPs for PCR testing</p> <p>Exclusion criteria: none specified</p>
Patient characteristics and setting	<p>Facility cases: all suspected patients with a positive RT-PCR</p> <p>Facility controls: all suspected patients with a negative RT-PCR</p> <p>Country: France</p> <p>Dates: 24 March 2020-14 April 2020</p> <p>Symptoms and severity: not specified</p> <p>Demographics: all included patients: median age: 45 years, % female: 65%</p> <p>Exposure history: not specified, 37% of participants were health-care professionals</p>
Index tests	<ul style="list-style-type: none"> • Anosmia or hyposmia • Ageusia or hypogeusia • Fever • Asthenia • Headache • Cough • Dyspnoea • Chest pain • Myalgia • Diarrhoea • Dry nose • Stuffy nose • Dry throat

Tudrej 2020 (Continued)

	<ul style="list-style-type: none">Sore throat		
Target condition and reference standard(s)	<ul style="list-style-type: none">TC: SARS-CoV-2 infectionRS: RT-PCR (nasopharyngeal swab)		
Flow and timing	RS specimen taken right after index tests, at presentation		
Comparative			
Notes			
Methodological quality			
Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Unclear		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		Low risk	
Are there concerns that the included patients and setting do not match the review question?			Low concern
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes		
If a threshold was used, was it pre-specified?	Unclear		
Could the conduct or interpretation of the index test have introduced bias?		High risk	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?			Low concern
DOMAIN 3: Reference Standard			
Is the reference standards likely to correctly classify the target condition?	Yes		
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear		
Could the reference standard, its conduct, or its interpretation have introduced bias?		Low risk	
Are there concerns that the target condition as defined by the reference standard does not match the question?			Low concern

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Tudrej 2020 (Continued)

DOMAIN 4: Flow and Timing

Was there an appropriate interval between index test and reference standard?	Yes
Did all patients receive the same reference standard?	Yes
Were all patients included in the analysis?	Yes
Could the patient flow have introduced bias?	Low risk

Wee 2020

Study characteristics

Patient Sampling	<p>Purpose: to analyse OTDs as a diagnostic criterion for COVID-19</p> <p>Design: cross-sectional, prospective single-centre study</p> <p>Recruitment: all suspected cases presenting to the ED</p> <p>Sample size: n = 870 (cases = 154)</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> • presence of respiratory symptoms and suspicious epidemiological links or travel history or • new onset OTD <p>Exclusion criteria: not specified</p>
Patient characteristics and setting	<p>Facility cases: positive RT-PCR for 2019-nCov</p> <p>Facility controls: negative RT-PCR for 2019-nCov</p> <p>Country: Singapore</p> <p>Dates: 26 March 2020-10 April 2020</p> <p>Symptoms and severity: loss of sense of smell/taste</p> <p>Demographics: not specified</p> <p>Exposure history: close contact of a confirmed COVID-19 case: cases 42/112, controls 37/679</p>
Index tests	<ul style="list-style-type: none"> • Loss of sense of smell/taste
Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: SARS-CoV-2 infection • RS: RT-PCR (oropharyngeal swabs)
Flow and timing	Time interval: same day
Comparative	
Notes	

Methodological quality

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Wee 2020 (Continued)

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Unclear		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Unclear		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		Low risk	
Are there concerns that the included patients and setting do not match the review question?			Low concern
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes		
If a threshold was used, was it pre-specified?	No		
Could the conduct or interpretation of the index test have introduced bias?		High risk	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?			Low concern
DOMAIN 3: Reference Standard			
Is the reference standards likely to correctly classify the target condition?	Yes		
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear		
Could the reference standard, its conduct, or its interpretation have introduced bias?		Low risk	
Are there concerns that the target condition as defined by the reference standard does not match the question?			Low concern
DOMAIN 4: Flow and Timing			
Was there an appropriate interval between index test and reference standard?	Yes		
Did all patients receive the same reference standard?	Yes		
Were all patients included in the analysis?	Yes		
Could the patient flow have introduced bias?		Low risk	

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Wei 2020

Study characteristics

Patient Sampling	<p>Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); diagnosis of SARS-CoV-2 in outpatients visiting a fever clinic</p> <p>Design: retrospective cohort study</p> <p>Recruitment: all febrile patients visiting the fever clinic of Tongji Hospital</p> <p>Sample size: n = 936 (628 cases)</p> <p>Inclusion criteria: all febrile patients visiting the fever clinic</p> <p>Exclusion criteria: none specified</p>
Patient characteristics and setting	<p>Facility cases: all febrile patients with a positive RT-PCR for SARS-CoV-2 (tested twice in 24 h)</p> <p>Facility controls: all febrile patients with a negative RT-PCR for SARS-CoV-2 (tested twice in 24 h)</p> <p>Country: China</p> <p>Dates: 30 January 2020-04 February 2020</p> <p>Symptoms and severity: cases: 88.1% mild, 11.5% severe, 0.5% critical; controls: 90.3% mild, 9.1% severe, 0.7% critical</p> <p>Demographics: median age: cases: 53 years, controls: 49 years. Gender: % female cases: 52.9%, controls: 53.9%</p> <p>Exposure history: not specified</p>
Index tests	<ul style="list-style-type: none"> • Fever • Cough • Fatigue • Chest tightness • Muscle ache • Diarrhea • Dyspnea • Anorexia • Rhinobyon • Vomiting • Sore throat • Aversion to cold • Nausea • Hypersomnia • Expectoration • Dizziness • Xerostomia • Chest pain • Abdominal distention
Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: SARS-CoV-2 infection

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Wei 2020 (Continued)

- RS: RT-PCR twice with a 24 h interval (throat-swab specimens from the upper respiratory tract)

Flow and timing	RS and index tests both taken at presentation		
Comparative			
Notes			
Methodological quality			
Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Yes		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		Unclear risk	
Are there concerns that the included patients and setting do not match the review question?			Low concern
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes		
If a threshold was used, was it pre-specified?	Unclear		
Could the conduct or interpretation of the index test have introduced bias?		High risk	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?			Low concern
DOMAIN 3: Reference Standard			
Is the reference standards likely to correctly classify the target condition?	Yes		
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear		
Could the reference standard, its conduct, or its interpretation have introduced bias?		Low risk	
Are there concerns that the target condition as defined by the reference standard does not match the question?			Low concern
DOMAIN 4: Flow and Timing			

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Wei 2020 (Continued)

Was there an appropriate interval between index test and reference standard?	Yes
Did all patients receive the same reference standard?	Yes
Were all patients included in the analysis?	Yes
Could the patient flow have introduced bias?	Low risk

Xie 2020

Study characteristics	
Patient Sampling	<p>Purpose: diagnosis of COVID-19 pneumonia; to compare the epidemiological, clinical, laboratory and radiological characteristics, treatment and outcomes between patients with confirmed COVID-19 pneumonia and those with suspected COVID-19 infection (71% of SARS-CoV-2-positive patients had CT-confirmed pneumonia)</p> <p>Design: retrospective 2-centre cohort</p> <p>Recruitment: patients in whom a RT-PCR test was performed at 2 Shanghai hospitals</p> <p>Sample size: n = 105 (21 cases)</p> <p>Inclusion criteria: not specified</p> <p>Exclusion criteria: not specified</p>
Patient characteristics and setting	<p>Facility cases: patients with a positive RT-PCR test for SARS-CoV-2</p> <p>Facility controls: patients with a negative RT-PCR test for SARS-CoV-2</p> <p>Country: China</p> <p>Dates: 01 January 2020-15 February 2020</p> <p>Symptoms and severity: 72% of all participants were hospitalised, 71% of the cases had pneumonia, 88% of controls had pneumonia ("clinical symptoms usually mild")</p> <p>Demographics: mean age: cases: 54.0 years, controls: 41.6 years. Gender: % female cases: 38.1%, controls: 51.2%</p> <p>Exposure history: recently been to Wuhan: cases: 42.9%, controls: 17.9%. Contact with people from Wuhan: cases: 14.3%, controls: 0%. Recently been to supermarkets and groceries: cases: 28.6%, controls: 34.5%. Recently travelled: cases: 14.3%, controls: 47.6%</p>
Index tests	<ul style="list-style-type: none"> • Fever • Cough • Sputum production • Myalgia • Weakness • Diarrhoea
Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: COVID-19 pneumonia

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Xie 2020 (Continued)

- RS: RT-PCR testing on throat swab and sputum specimens, patients pre-selected on the presence of pneumonia (radiological findings)

Flow and timing	RS and index tests both taken at admission		
Comparative			
Notes			
Methodological quality			
Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Unclear		
Was a case-control design avoided?	Unclear		
Did the study avoid inappropriate exclusions?	Unclear		
Did the study avoid inappropriate inclusions?	Unclear		
Could the selection of patients have introduced bias?		Unclear risk	
Are there concerns that the included patients and setting do not match the review question?			Unclear
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes		
If a threshold was used, was it pre-specified?	Unclear		
Could the conduct or interpretation of the index test have introduced bias?		High risk	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?			Low concern
DOMAIN 3: Reference Standard			
Is the reference standards likely to correctly classify the target condition?	Yes		
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear		
Could the reference standard, its conduct, or its interpretation have introduced bias?		Low risk	
Are there concerns that the target condition as defined by the reference standard does not match the question?			Low concern

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Xie 2020 (Continued)

DOMAIN 4: Flow and Timing

Was there an appropriate interval between index test and reference standard?	Yes
Did all patients receive the same reference standard?	Yes
Were all patients included in the analysis?	Yes
Could the patient flow have introduced bias?	High risk

Yan 2020

Study characteristics

Patient Sampling	<p>Purpose: to evaluate association of patient-reported symptoms with a focus on sense of smell and taste and SARS-CoV-2 infection</p> <p>Design: internet survey of patients after presentation to a single centre</p> <p>Recruitment: email invitation with 1 phone call follow-up to every-one who was tested for COVID-19 between 3 March 2020 and 29 March 2020</p> <p>Sample size: n = 262 (cases: 59)</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> adult patients who presented to the institution and got tested for COVID-19 analysis on responders to email survey (responses: cases 59/102, controls 203/1378) <p>Exclusion criteria:</p>
Patient characteristics and setting	<p>Facility cases: SARS-CoV-2-positive</p> <p>Facility controls: SARS-CoV-2-negative</p> <p>Country: USA, San Diego</p> <p>Dates: 3 March 2020-29 March 2020</p> <p>Symptoms and severity:</p> <ul style="list-style-type: none"> larger representation of ambulatory patients (higher response rate to survey) severity - hospital admission: cases 4/59, controls 14/203 <p>Demographics: adults only, M/F: cases 29/29, controls 69/132</p> <p>Exposure history: not specified</p>
Index tests	<ul style="list-style-type: none"> Fatigue Loss of taste Fever Loss of sense of smell

Yan 2020 (Continued)

- Cough
- Headache
- Myalgia
- Dyspnoea
- Diarrhoea
- Nasal obstruction
- Sore throat
- Rhinorrhoea
- Nausea

Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: SARS-CoV-2 infection • RS: PCR for SARS-CoV-2 (sample not specified)
Flow and timing	PCR taken at presentation, not specified when the questionnaire was sent. Patients had to list their symptoms at presentation.
Comparative	
Notes	

Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Unclear		
Did the study avoid inappropriate inclusions?	Unclear		
Could the selection of patients have introduced bias?		Unclear risk	
Are there concerns that the included patients and setting do not match the review question?			Unclear
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	No		
If a threshold was used, was it pre-specified?	No		
Could the conduct or interpretation of the index test have introduced bias?		High risk	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?			Low concern
DOMAIN 3: Reference Standard			

Yan 2020 (Continued)

Is the reference standards likely to correctly classify the target condition?	Unclear
Were the reference standard results interpreted without knowledge of the results of the index tests?	Yes
Could the reference standard, its conduct, or its interpretation have introduced bias?	Low risk
Are there concerns that the target condition as defined by the reference standard does not match the question?	Low concern
DOMAIN 4: Flow and Timing	
Was there an appropriate interval between index test and reference standard?	Unclear
Did all patients receive the same reference standard?	Yes
Were all patients included in the analysis?	Yes
Could the patient flow have introduced bias?	Unclear risk

Yang 2020

Study characteristics	
Patient Sampling	<p>Purpose: to identify differences in CT imaging and clinical features between COVID-19 and influenza pneumonia in the early stage, and to identify the most valuable features in the differential diagnosis</p> <p>Design: diagnostic case-control study, retrospective, multicentre with historic control group</p> <p>Recruitment: cases: confirmed SARS-CoV-2 patients; controls: influenza pneumonia patients (1 January 2015-30 September 2019 from 2 hospitals)</p> <p>Sample size: n = 121 (73 cases)</p> <p>Inclusion criteria: patients confirmed with SARS-CoV-2; controls: patients who had 9 respiratory pathogen IgM antibody tested from January 2015-September 2019</p> <p>Exclusion criteria: cases: not specified</p> <p>controls:</p> <ul style="list-style-type: none"> • parainfluenza • respiratory syncytial virus • adenovirus • Legionella spp • <i>Mycoplasma pneumoniae</i> • <i>Chlamydia pneumoniae</i> • <i>Coxiella burnetii</i> • aspiration pneumonia • radiation pneumonia

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Yang 2020 (Continued)

- pulmonary contusion
- pulmonary oedema
- neoplasm

No CT date, no clinical date

Patient characteristics and setting	<p>Facility cases: positive RT-PCR for 2019-nCov</p> <p>Facility controls: influenza pneumonia</p> <p>Country: China</p> <p>Dates: 1 January 2020-15 February 2020</p> <p>Symptoms and severity: all patients in early stages of COVID-19 or influenza pneumonia</p> <p>Demographics: M/F: cases 41/32, controls 30/18 mean age: cases 41.9, controls 40.4</p> <p>Exposure history: not specified</p>
Index tests	<ul style="list-style-type: none"> • Body temperature • Cough • Fatigue • Sore throat • Stuffy and runny nose
Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: COVID-19 pneumonia • RS: RT-PCR (sample not specified)
Flow and timing	Time interval unclear
Comparative	
Notes	Overlaps with Chen 2020

Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	No		
Did the study avoid inappropriate exclusions?	Unclear		
Did the study avoid inappropriate inclusions?	No		
Could the selection of patients have introduced bias?		High risk	
Are there concerns that the included patients and setting do not match the review question?			High
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Unclear		

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Yang 2020 (Continued)

If a threshold was used, was it pre-specified?	No
Could the conduct or interpretation of the index test have introduced bias?	High risk
Are there concerns that the index test, its conduct, or interpretation differ from the review question?	Low concern
DOMAIN 3: Reference Standard	
Is the reference standards likely to correctly classify the target condition?	Yes
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear
Could the reference standard, its conduct, or its interpretation have introduced bias?	High risk
Are there concerns that the target condition as defined by the reference standard does not match the question?	High
DOMAIN 4: Flow and Timing	
Was there an appropriate interval between index test and reference standard?	Unclear
Did all patients receive the same reference standard?	Yes
Were all patients included in the analysis?	Yes
Could the patient flow have introduced bias?	Unclear risk

Yombi 2020

Study characteristics	
Patient Sampling	<p>Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); diagnosis of SARS-CoV-2 infection, using clinical signs in HCWs</p> <p>Design: cross-sectional cohort study (unclear whether retrospective/prospective data collection)</p> <p>Recruitment: period 1: (before 30 March 2020) HCWs were tested only if they had fever and respiratory symptoms (some physicians were tested without fever); period 2 (after 30 March 2020), HCWs were tested if they had respiratory symptoms with or without fever</p> <p>Sample size: n = 536 (175 cases)</p> <p>Inclusion criteria: not specified (all suspected HCWs)</p> <p>Exclusion criteria: not specified</p>
Patient characteristics and setting	Facility cases: all suspected HCWs with a positive RT-PCR

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Yombi 2020 (Continued)

Facility controls: all suspected HCWs with a negative RT-PCR

Country: Belgium

Dates: 16 March 2020-24 April 2020

Symptoms and severity: not specified (from tables: mild to moderate severity)

Demographics: % age < 45 years: cases: 56.6%, controls: 62.3%
gender: % female cases: 67.4%, controls: 73.1%

Exposure history: not specified (all HCWs)

Index tests	<ul style="list-style-type: none">• Fever• Cough• Shortness of breath• Sore throat• Fever + cough• Fever + cough + shortness of breath• Fever + cough + sore throat		
Target condition and reference standard(s)	<ul style="list-style-type: none">• TC: SARS-CoV-2 infection• RS: PCR for SARS-CoV-2 (sample not specified)		
Flow and timing	Not specified		
Comparative			
Notes			
Methodological quality			
Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Unclear		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Unclear		
Did the study avoid inappropriate inclusions?	Unclear		
Could the selection of patients have introduced bias?		Unclear risk	
Are there concerns that the included patients and setting do not match the review question?			Unclear
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes		
If a threshold was used, was it pre-specified?	Unclear		

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Yombi 2020 (Continued)

Could the conduct or interpretation of the index test have introduced bias?	High risk
Are there concerns that the index test, its conduct, or interpretation differ from the review question?	Low concern
DOMAIN 3: Reference Standard	
Is the reference standards likely to correctly classify the target condition?	Yes
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear
Could the reference standard, its conduct, or its interpretation have introduced bias?	Low risk
Are there concerns that the target condition as defined by the reference standard does not match the question?	Low concern
DOMAIN 4: Flow and Timing	
Was there an appropriate interval between index test and reference standard?	Unclear
Did all patients receive the same reference standard?	Yes
Were all patients included in the analysis?	Unclear
Could the patient flow have introduced bias?	Unclear risk

Zavascki 2020

Study characteristics	
Patient Sampling	<p>Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); development of a predictive score for SARS-CoV-2 infection based on demographics and symptoms in patients who attended at a dedicated screening unit.</p> <p>Design: retrospective cohort study</p> <p>Recruitment: all patients with suspected COVID-19 visiting a dedicated screening centre of a private tertiary-care hospital in the study period were eligible. Suspicion = fever or any respiratory symptom and have returned from countries with confirmed COVID-19 cases in the last 14 days (after 14 March, travel history was not necessary)</p> <p>Sample size: n = 464 (98 cases)</p> <p>Inclusion criteria: consecutive patients attending the screening clinic</p> <p>Exclusion criteria: health-care professionals, < 18 years old, asymptomatic patients</p>
Patient characteristics and setting	Facility cases: patients with suspected COVID-19 with 1 positive RT-PCR

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Zavascki 2020 (Continued)

Facility controls: patients with suspected COVID-19 with ≥ 1 negative RT-PCR

Country: Brazil

Dates: 28 January 2020-13 April 2020

Symptoms and severity: mild to moderate severity

Demographics: mean age: cases: 59.1 years, controls: 45.4 years % ≥ 60 years: cases: 55.1%, controls: 21.0% gender: % female cases: 37.8%, controls: 57.1%

Exposure history: not specified

Index tests	<ul style="list-style-type: none"> Fever Cough Sore throat Dyspnea Coryza Nasal congestion Fatigue Myalgia Headache Diarrhoea Nausea
Target condition and reference standard(s)	<ul style="list-style-type: none"> TC: SARS-CoV-2 infection RS: PCR for SARS-CoV-2 (sample not specified)
Flow and timing	RS and index test both on the day of presentation
Comparative	
Notes	

Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	No		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		High risk	
Are there concerns that the included patients and setting do not match the review question?			Low concern
DOMAIN 2: Index Test (All tests)			

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Zavascki 2020 (Continued)

Were the index test results interpreted without knowledge of the results of the reference standard?	Yes
If a threshold was used, was it pre-specified?	Unclear
Could the conduct or interpretation of the index test have introduced bias?	High risk
Are there concerns that the index test, its conduct, or interpretation differ from the review question?	Low concern
DOMAIN 3: Reference Standard	
Is the reference standards likely to correctly classify the target condition?	Yes
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear
Could the reference standard, its conduct, or its interpretation have introduced bias?	Low risk
Are there concerns that the target condition as defined by the reference standard does not match the question?	Low concern
DOMAIN 4: Flow and Timing	
Was there an appropriate interval between index test and reference standard?	Yes
Did all patients receive the same reference standard?	Yes
Were all patients included in the analysis?	Yes
Could the patient flow have introduced bias?	Low risk

Zayet 2020a

Study characteristics

Patient Sampling	<p>Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); to compare the clinical features of COVID-19 and influenza</p> <p>Design: case-control study (COVID cases vs influenza cases)</p> <p>Recruitment: all adult patients (> 18 years) with confirmed COVID- 19 or confirmed influenza A/B who consulted or were hospitalised in the hospital</p> <p>Sample size: n = 124 (70 cases)</p> <p>Inclusion criteria: all adult patients with symptoms (suspicion of SARS-CoV-2 or Influenza) with either confirmed SARS-CoV-2 infection or confirmed influenza A/ B infection 'suspicion' not defined</p> <p>Exclusion criteria: pregnant women, children (< 18 years) and patients with dementia (unable to report functional symptoms) + not specified but following</p>
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Zayet 2020a (Continued)

from inclusion criteria: patients testing negative for both SARS-CoV-2 and influenza A/B

Patient characteristics and setting	<p>Facility cases: patients with suspected COVID-19 with a positive RT-PCR for SARS-CoV-2</p> <p>Facility controls: patients with suspected COVID-19 with a positive RT-PCR for influenza A/B</p> <p>Country: France</p> <p>Dates: 26 February 2020-14 March 2020</p> <p>Symptoms and severity: mild to moderate severity, 33 patients (47%) were hospitalised for a mean duration of 7 days (± 6). During hospitalisation, 23 patients (33%) required oxygen therapy and 11 patients (16%) were admitted to ICU for acute respiratory failure and needed artificial ventilation for 8 days (± 7)</p> <p>Demographics: mean age: cases: 56.7 years, controls: 61.3 years. Gender: % female cases: 58.6%, controls: 68.5%</p> <p>Exposure history: not specified (31.4% of cases were HCWs versus 5.6% of controls)</p>
Index tests	<ul style="list-style-type: none"> • Fever • Fatigue • Myalgia • Arthralgia • Headache • Cough • Sputum production • Sneezing • Chest pain • Haemoptysis • Dyspnoea • Tinnitus • Sore throat • Hearing loss • Dysgeusia • Anosmia • Rhinorrhea • Nasal obstruction • Epistaxis • Conjunctival hyperemia • Tearing • Dry eyes • Blurred vision • Nausea • Vomiting • Diarrhoea • Abdominal pain
Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: SARS-CoV-2 infection • RS: PCR for SARS-CoV-2 (nasopharyngeal swabs, sputum, bronchial aspirates or bronchoalveolar lavage fluids)

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Zayet 2020a (Continued)

Flow and timing	Not specified		
Comparative			
Notes			
Methodological quality			
Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	No		
Was a case-control design avoided?	No		
Did the study avoid inappropriate exclusions?	No		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		High risk	
Are there concerns that the included patients and setting do not match the review question?			High
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Unclear		
If a threshold was used, was it pre-specified?	Unclear		
Could the conduct or interpretation of the index test have introduced bias?		High risk	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?			Low concern
DOMAIN 3: Reference Standard			
Is the reference standards likely to correctly classify the target condition?	Yes		
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear		
Could the reference standard, its conduct, or its interpretation have introduced bias?		Low risk	
Are there concerns that the target condition as defined by the reference standard does not match the question?			Low concern

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Zayet 2020a (Continued)

DOMAIN 4: Flow and Timing

Was there an appropriate interval between index test and reference standard?	Unclear
Did all patients receive the same reference standard?	Yes
Were all patients included in the analysis?	Yes
Could the patient flow have introduced bias?	Unclear risk

Zayet 2020b

Study characteristics

Patient Sampling	<p>Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); to compare the symptoms of patients with positive and negative SARS-CoV-2 RT-PCR results and to determine the sensitivity, specificity, positive predictive value and negative predictive value for each of these symptoms in regard to SARS-CoV-2 RT-PCR</p> <p>Design: retrospective cohort study</p> <p>Recruitment: all adult patients (≥ 18 years) who presented for possible COVID-19 at the outpatient department</p> <p>Sample size: n = 217 (95 cases)</p> <p>Inclusion criteria: all adult patients (≥ 18 years) who presented for possible COVID-19 at the outpatient department</p> <p>Exclusion criteria: pregnant women, children (< 18 years) and patients with dementia (unable to report functional symptoms)</p>
Patient characteristics and setting	<p>Facility cases: patients with suspected COVID-19 with a positive RT-PCR</p> <p>Facility controls: patients with suspected COVID-19 with a negative RT-PCR</p> <p>Country: France</p> <p>Dates: 30 March 2020-03 April 2020</p> <p>Symptoms and severity: mild to moderate severity</p> <p>Demographics: mean age: cases: 39.8 years, controls: 39.6 years. Gender: % female cases: 83.2%, controls: 86.9%</p> <p>Exposure history: not specified (mostly HCWs)</p>
Index tests	<ul style="list-style-type: none"> Fever Myalgia/arthralgia Headache Cough Dyspnoea Dysgeusia

Zayet 2020b (Continued)

- Anosmia
- Rhinorrhea
- GI symptoms

Target condition and reference standard(s)	<ul style="list-style-type: none">• TC: SARS-CoV-2 infection• RS: PCR for SARS-CoV-2 (nasopharyngeal swabs)		
Flow and timing	Not specified		
Comparative			
Notes			
Methodological quality			
Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Unclear		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		Unclear risk	
Are there concerns that the included patients and setting do not match the review question?			Low concern
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Unclear		
If a threshold was used, was it pre-specified?	Unclear		
Could the conduct or interpretation of the index test have introduced bias?		High risk	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?			Low concern
DOMAIN 3: Reference Standard			
Is the reference standards likely to correctly classify the target condition?	Yes		
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear		
Could the reference standard, its conduct, or its interpretation have introduced bias?		Low risk	

Zayet 2020b (Continued)

Are there concerns that the target condition as defined by the reference standard does not match the question?

Low concern

DOMAIN 4: Flow and Timing

Was there an appropriate interval between index test and reference standard? Unclear

Did all patients receive the same reference standard? Yes

Were all patients included in the analysis? Yes

Could the patient flow have introduced bias?

Unclear risk

Zhao 2020

Study characteristics

Patient Sampling

Purpose: to compare and assess the clinical features of COVID-19 pneumonia with features in non-COVID-19 pneumonia patients

Design: diagnostic case control, retrospective study

Recruitment: patients with similar duration between symptom onset to admission were selected as controls

Sample size: n = 34 (n = 15)

Inclusion criteria: admitted pneumonia cases with a history of travel to Hubei or exposure to a PCR SARS-CoV-2-confirmed-positive patient

Exclusion criteria: not specified

Patient characteristics and setting

Facility cases: single sputum or throat swab test RT-PCR-positive pneumonia

Facility controls: for non-COVID-19 confirmation: 3 consecutive negative throat swabs or sputum sampling every other day during first 7 days of admission

Country: China, Anhui

Dates: 23 January 2020-5 February 2020

Symptoms and severity:

- fever
- cough
- sore throat
- headache
- fatigue
- diarrhoea
- chest tightness
- abnormal lung auscultation

Demographics: mean age (cases/controls): 48 (IQR 27~56)/35 (IQR 27~46) in COVID-19 and non-COVID-19 patients, respectively; F/M (cases/controls): 8 (42.11%)

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Zhao 2020 (Continued)

Exposure history: all patients had a history of exposure to confirmed cases of 2019-nCoV or travel to Hubei before illness. Investigators interviewed each patient and their relatives, where necessary, to determine exposure or close contact histories during the 2 weeks before the illness onset

Index tests	<ul style="list-style-type: none">FeverCoughSore throatHeadacheFatigueDiarrhoeaChest tightnessAbnormal lung auscultation		
Target condition and reference standard(s)	<ul style="list-style-type: none">TC: COVID-19 pneumoniaRS: real-time RT-PCR (unknown assay) (sample: throat swabs or/and sputa)		
Flow and timing	Time interval not specified		
Comparative			
Notes			
Methodological quality			
Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	No		
Was a case-control design avoided?	No		
Did the study avoid inappropriate exclusions?	Unclear		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		High risk	
Are there concerns that the included patients and setting do not match the review question?			High
DOMAIN 2: Index Test (All tests)			
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes		
If a threshold was used, was it pre-specified?	No		
Could the conduct or interpretation of the index test have introduced bias?		High risk	

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Zhao 2020 (Continued)

Are there concerns that the index test, its conduct, or interpretation differ from the review question?		Low concern
DOMAIN 3: Reference Standard		
Is the reference standards likely to correctly classify the target condition?	Yes	
Were the reference standard results interpreted without knowledge of the results of the index tests?	Yes	
Could the reference standard, its conduct, or its interpretation have introduced bias?		Unclear risk
Are there concerns that the target condition as defined by the reference standard does not match the question?		Low concern
DOMAIN 4: Flow and Timing		
Was there an appropriate interval between index test and reference standard?	Unclear	
Did all patients receive the same reference standard?	Yes	
Were all patients included in the analysis?	Yes	
Could the patient flow have introduced bias?		Unclear risk

Zhu 2020

Study characteristics	
Patient Sampling	<p>Purpose: description of initial clinical features in patients with suspected and confirmed SARS-CoV-2 infection</p> <p>Design: cross-sectional, retrospective study</p> <p>Recruitment: all patients with suspected COVID-19 who presented to the ED of the First Affiliated Hospital of USTC and the Infectious Hospital of the First Affiliated Hospital of USTC for the first time</p> <p>Sample size: n = 116 (32 cases)</p> <p>Inclusion criteria:</p> <ul style="list-style-type: none"> patients defined as suspected SARS-CoV-2 infection based on guidelines for the diagnosis and treatment of pneumonia caused by novel coronavirus infection (trial version III) presentation to, clinical observation and quarantine in our ED nucleic acid amplification test performed in the ED <p>Exclusion criteria: transfer from another hospital or previous visit to our hospital and previous diagnosis of COVID-19</p>
Patient characteristics and setting	Facility cases: positive nucleic acid amplification test on admission or 24 h later

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Zhu 2020 (Continued)

Facility controls: SARS-CoV-2 PCR test negative

Country: China, Anhui

Dates: 24 January 2020-20 February 2020

Symptoms and severity: all suspected COVID-19 patients included; days since onset of symptoms median 5 (IQR 2-7)

Demographics: median age: all: 40 years (IQR 27-53), cases: 46 years (IQR 35-52), controls: 35 years (IQR 27-53); gender distribution M%/F%: all 46/54, cases 47/53, controls 46/54

Exposure history: no specific exposure history common to all patients with suspected disease: 8 (25%) diagnosed patients had visited Wuhan in the previous 2 weeks and 12 (38%) had been exposed to patients with infection in the previous 2 weeks

Index tests	<ul style="list-style-type: none">• Fever• Cough• Myalgia or fatigue• Expectoration• Chest stuffiness (congestion)• Haemoptysis• Headache• Diarrhoea		
Target condition and reference standard(s)	<ul style="list-style-type: none">• TC: SARS-CoV-2 infection• RS: nucleic acid amplification test not further specified (twice in case negatives) (samples: swabs, origin not specified)		
Flow and timing	Index tests and RS both taken on admission or after 24 h		
Comparative			
Notes			
Methodological quality			
Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Yes		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Yes		
Did the study avoid inappropriate inclusions?	Yes		
Could the selection of patients have introduced bias?		Low risk	
Are there concerns that the included patients and setting do not match the review question?			Low concern

Signs and symptoms to determine if a patient presenting in primary care or hospital outpatient settings has COVID-19 (Review)

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Zhu 2020 (Continued)

DOMAIN 2: Index Test (All tests)

Were the index test results interpreted without knowledge of the results of the reference standard? Yes

If a threshold was used, was it pre-specified? No

Could the conduct or interpretation of the index test have introduced bias? High risk

Are there concerns that the index test, its conduct, or interpretation differ from the review question? Low concern

DOMAIN 3: Reference Standard

Is the reference standards likely to correctly classify the target condition? Yes

Were the reference standard results interpreted without knowledge of the results of the index tests? Unclear

Could the reference standard, its conduct, or its interpretation have introduced bias? Unclear risk

Are there concerns that the target condition as defined by the reference standard does not match the question? Low concern

DOMAIN 4: Flow and Timing

Was there an appropriate interval between index test and reference standard? Yes

Did all patients receive the same reference standard? Yes

Were all patients included in the analysis? Yes

Could the patient flow have introduced bias? Unclear risk

Zimmerman 2020

Study characteristics

Patient Sampling

Purpose: diagnosis of SARS-CoV-2 infection (mild COVID-19 disease); to develop a data-driven set of clinical indicators for COVID-19 that would help to identify outpatient symptoms and those who most benefit from limited testing availability

Design: not specified

Recruitment: not specified

Sample size: n = 736 (55 cases)

Inclusion criteria: not specified

Signs and symptoms to determine if a patient presenting in primary care or hospital outpatient settings has COVID-19 (Review)

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Zimmerman 2020 (Continued)

Exclusion criteria: not specified

Patient characteristics and setting	<p>Facility cases: adult patients testing positive for SARS-CoV-2 infection</p> <p>Facility controls: adult patients testing negative for SARS-CoV-2 infection</p> <p>Country: Pennsylvania, USA</p> <p>Dates: 29 March 2020-26 April 2020</p> <p>Symptoms and severity: mild to moderate severity</p> <p>Demographics: not specified</p> <p>Exposure history: contact with COVID-19 case: cases: 70%, controls: 21%</p>
-------------------------------------	---

Index tests	<ul style="list-style-type: none"> • Fever • Chills • Cough • Sore throat • Shortness of breath • Muscle aches • Abdominal pain • Nausea/vomiting • Diarrhoea • Headache • Decrease or loss of taste or smell
-------------	--

Target condition and reference standard(s)	<ul style="list-style-type: none"> • TC: SARS-CoV-2 infection • RS: PCR for SARS-CoV-2 (specimen not specified)
--	---

Flow and timing	Not specified
-----------------	---------------

Comparative	
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Notes	
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Methodological quality

Item	Authors' judgement	Risk of bias	Applicability concerns
DOMAIN 1: Patient Selection			
Was a consecutive or random sample of patients enrolled?	Unclear		
Was a case-control design avoided?	Yes		
Did the study avoid inappropriate exclusions?	Unclear		
Did the study avoid inappropriate inclusions?	Unclear		
Could the selection of patients have introduced bias?		Unclear risk	

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Zimmerman 2020 (Continued)

Are there concerns that the included patients and setting do not match the review question?		Unclear
DOMAIN 2: Index Test (All tests)		
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes	
If a threshold was used, was it pre-specified?	Unclear	
Could the conduct or interpretation of the index test have introduced bias?		High risk
Are there concerns that the index test, its conduct, or interpretation differ from the review question?		Low concern
DOMAIN 3: Reference Standard		
Is the reference standards likely to correctly classify the target condition?	Yes	
Were the reference standard results interpreted without knowledge of the results of the index tests?	Unclear	
Could the reference standard, its conduct, or its interpretation have introduced bias?		Low risk
Are there concerns that the target condition as defined by the reference standard does not match the question?		Low concern
DOMAIN 4: Flow and Timing		
Was there an appropriate interval between index test and reference standard?	Unclear	
Did all patients receive the same reference standard?	Yes	
Were all patients included in the analysis?	Yes	
Could the patient flow have introduced bias?		Unclear risk

BP: blood pressure; **COPD:** constructive obstructive pulmonary disease; **COVID-19:** coronavirus disease 2019; **CT:** computed tomography; **ED:** emergency department; **F:** female; **FiO₂:** fraction of inspired oxygen; **GI:** gastrointestinal; **GP:** general practitioner; **HCW:** healthcare workers; **ICU:** intensive care unit; **IgM:** immunoglobulin M; **IQR:** interquartile range; **M:** male; **NCP:** novel coronavirus pneumonia; **OTD:** olfactory and taste disorder; **PaO₂:** partial pressure of oxygen; **RS:** reference standard; **RT-PCR:** reverse transcription polymerase chain reaction; **SARS-CoV-2:** severe acute respiratory syndrome coronavirus 2; **SD:** standard deviation; **SpO₂:** oxygen saturation; **TC:** target condition; **WBC:** blood white blood cell; **WHO:** World Health Organization; **2019-nCoV:** 2019 novel coronavirus

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Guan 2020	SARS-CoV-2-positive cases only
Soares 2020	No data

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Study	Reason for exclusion
Song 2020b	SARS-CoV-2-positive cases only
Wang 2020	No data

DATA

Presented below are all the data for all of the tests entered into the review.

Table Tests. Data tables by test

Test	No. of studies	No. of participants
1 Fever	27	17948
2 Cough	25	15459
3 Dyspnoea	24	14913
4 Sore throat	20	15876
5 Diarrhoea	20	13016
6 Headache	18	13173
7 Myalgia	13	8105
8 Fatigue	12	5553
9 Sputum production	11	5260
10 Anosmia	11	9552
11 Nausea or vomiting	8	5381
12 Ageusia	6	7393
13 Anosmia or ageusia	6	8142
14 Chest tightness	6	6057
15 Chills	6	4151
16 Nasal congestion	6	5256
17 Abdominal pain	5	2241
18 Rhinorrhea	5	2252
19 Myalgia or arthralgia	5	556
20 Nasal symptoms	5	2405

Signs and symptoms to determine if a patient presenting in primary care or hospital outpatient settings has COVID-19 (Review)

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Test	No. of studies	No. of participants
21 Nausea	4	2050
22 Haemoptysis	4	1986
23 Gastrointestinal symptoms (not specified)	4	4331
24 Dry cough	3	1752
25 Vomiting	3	1586
26 Skin lesions	3	1500
27 Anosmia and ageusia	2	2640
28 Anosmia or dysgeusia	2	457
29 Anorexia	2	1270
30 Coryza	2	3399
31 Wheeze	2	866
32 Myalgia or fatigue	2	1427
33 Fever (subjective)	2	3251
34 High fever ($\geq 38.5^{\circ}\text{C}$)	2	3939
35 Altered mentation	2	707
36 Weakness or fatigue	2	580
37 Tachycardia	2	3689
38 Loss of appetite	2	1965
39 Hypoxia	1	2929
41 Respiratory symptoms (not specified))	1	788
42 Rhinitis or pharyngitis	1	391
43 Sinusitis	1	2935
44 Isolated fever	1	598
45 Low body temperature	1	3384
46 Shivers	1	132
47 Arthralgia	1	37
48 Systemic soreness (malaise/myalgia/arthralgia)	1	2935
49 Abdominal distension	1	936

Signs and symptoms to determine if a patient presenting in primary care or hospital outpatient settings has COVID-19 (Review)

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Test	No. of studies	No. of participants
50 Low systolic blood pressure	1	3341
51 High systolic blood pressure	1	3341
52 Palpitations	1	132
53 Tachypnea	1	316
54 Lethargy	1	773
55 Hyposmia	1	717
56 Dysgeusia	1	217
57 Anosmia and dysgeusia	1	217
58 Rash	1	475
59 Isolated headache	1	598
60 Diarrhea and nausea	1	598
61 Dizziness or syncope	1	391
62 Earache	1	475
63 Enlargement of lymph nodes	1	475
64 Stomachache	1	475
65 Arthralgia	1	475
66 Unconsciousness	1	475
67 Aversion to cold	1	936
68 Xerostomia	1	936
69 Hypersomnia	1	936
70 Sneezing	1	1004
71 Change to chronic cough	1	240
72 Dizziness	1	936
73 Positive auscultation findings	1	788
74 Pulmonary auscultation: crackling bilateral	1	391
75 Pulmonary auscultation: crackling unilateral	1	391
76 Conjunctivitis	1	37
77 Myalgia and asthenia and fever	1	598

Signs and symptoms to determine if a patient presenting in primary care or hospital outpatient settings has COVID-19 (Review)

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Test	No. of studies	No. of participants
78 Fever and cough	1	536
79 Fever and cough and sore throat	1	536
80 Fever and cough and dyspnea	1	536
81 Cough and fever and sputum production	1	598
82 Cough and fever and sputum production and dyspnea	1	598
83 Sore throat and nasal congestion and sneezing and mild fever	1	598
84 Dyspnea and cough and fever and low oxygen saturation	1	598
85 Cough (non-cross-sectional study)	7	1097
86 Sore throat (non-cross-sectional study)	6	952
87 Positive auscultation findings (non-cross-sectional study)	3	375
88 Rhinorrhoea (non-cross-sectional study)	5	917
89 Dyspnoea (non-cross-sectional study)	4	781
90 Ageusia (non-cross-sectional study)	1	262
91 Chest tightness (non-cross-sectional study)	3	426
92 Fever (non-cross-sectional study)	6	961
93 Fatigue (non-cross-sectional study)	5	683
94 Myalgia or arthralgia (non-cross-sectional study)	1	262
95 Headache (non-cross-sectional study)	5	815
96 Diarrhoea (non-cross-sectional study)	6	1331
97 Nausea/vomiting (non-cross-sectional study)	1	516
98 Red eyes (non-cross-sectional study)	1	268
99 Gastrointestinal symptoms, not specified (non-cross-sectional study)	1	516
100 Asthenia (non-cross-sectional study)	1	268
101 Fever (subjective, non-cross-sectional study))	3	392
102 Arthralgia (non-cross-sectional study)	2	392
103 Sneezing (non-cross-sectional study)	2	392
104 Rash (non-cross-sectional study)	1	268
105 Loss of temp. sens. in face (non-cross-sectional study)	1	268

Signs and symptoms to determine if a patient presenting in primary care or hospital outpatient settings has COVID-19 (Review)

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Test	No. of studies	No. of participants
106 Vertigo or dizziness (non-cross-sectional study)	1	268
107 Blurred vision (non-cross-sectional study)	2	392
108 Nasal congestion (non-cross-sectional study)	5	917
109 Dysgeusia (non-cross-sectional study)	2	392
110 Anosmia (non-cross-sectional study)	4	781
111 Loss of appetite (non-cross-sectional study)	1	268
112 Myalgia (non-cross-sectional study)	2	392
113 Anosmia or dysgeusia (non-cross-sectional study)	1	268
114 Sputum production (non-cross-sectional study)	2	392
115 Chills (non-cross-sectional study)	1	268
116 Nausea (non-cross-sectional study)	3	654
117 Vomiting (non-cross-sectional study)	2	392
119 Abdominal pain (non-cross-sectional study)	2	251
120 Conjunctival hyperemia (non-cross-sectional study)	1	124
121 Diffuse headache (non-cross-sectional study)	1	124
122 Frontal headache (non-cross-sectional study)	1	124
123 Epistaxis (non-cross-sectional study)	1	124
124 Dry eyes (non-cross-sectional study)	1	124
125 Haemoptysis (non-cross-sectional study)	1	124
126 Hearing loss (non-cross-sectional study)	1	124
127 Pulmonary auscultation: crackling bilateral (non-cross-sectional study)	1	124
128 Pulmonary auscultation: crackling unilateral (non-cross-sectional study)	1	124
129 Pulmonary auscultation: rhonchi (non-cross-sectional study)	1	124
130 Pulmonary auscultation: sibilant (non-cross-sectional study)	1	124
131 Tachypnea (non-cross-sectional study)	1	124
132 Tinnitus (non-cross-sectional study)	1	124
133 Tearing (non-cross-sectional study)	1	124
134 Dysgeusia or ageusia (non-cross-sectional study)	1	127

Signs and symptoms to determine if a patient presenting in primary care or hospital outpatient settings has COVID-19 (Review)





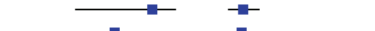

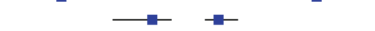














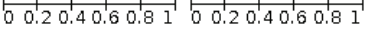





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Test	No. of studies	No. of participants
135 Hyposmia (non-cross-sectional study)	1	127

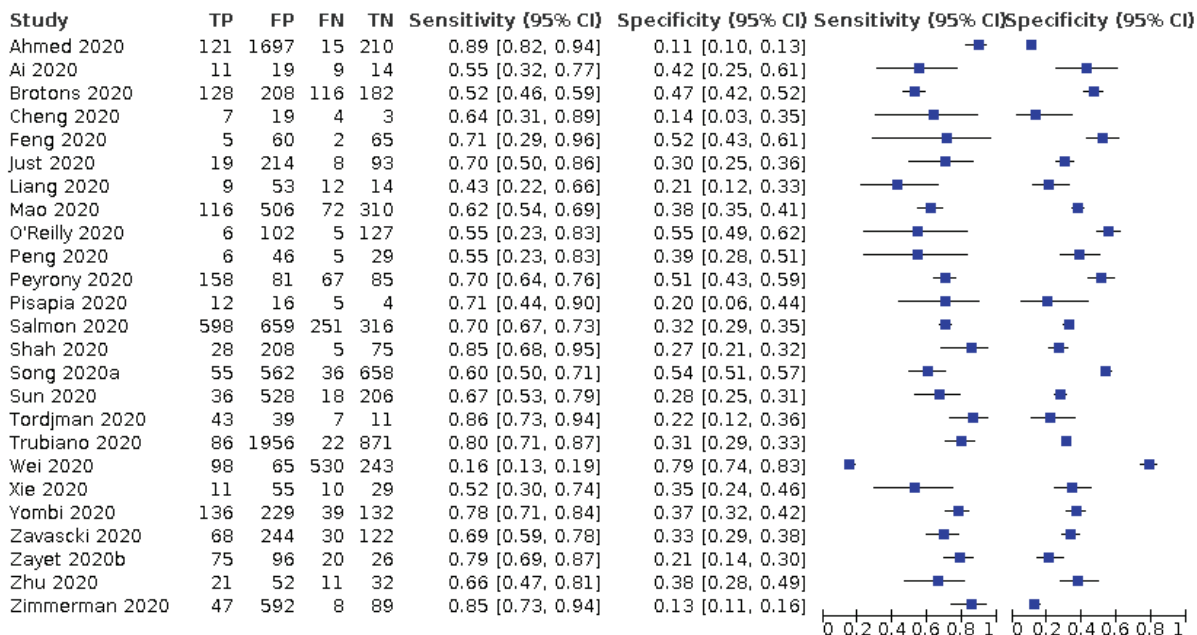
Test 1. Fever

Fever

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Ahmed 2020	103	1229	33	678	0.76 [0.68, 0.83]	0.36 [0.33, 0.38]		
Al 2020	16	17	4	16	0.80 [0.56, 0.94]	0.48 [0.31, 0.66]		
Brotons 2020	120	86	124	304	0.49 [0.43, 0.56]	0.78 [0.74, 0.82]		
Cheng 2020	8	17	3	5	0.73 [0.39, 0.94]	0.23 [0.08, 0.45]		
Clemency 2020	143	323	82	413	0.64 [0.57, 0.70]	0.56 [0.52, 0.60]		
Feng 2020	6	87	1	38	0.86 [0.42, 1.00]	0.30 [0.22, 0.39]		
Huang 2020	216	98	120	41	0.64 [0.59, 0.69]	0.29 [0.22, 0.38]		
Just 2020	9	84	18	223	0.33 [0.17, 0.54]	0.73 [0.67, 0.78]		
Liang 2020	18	56	3	11	0.86 [0.64, 0.97]	0.16 [0.08, 0.27]		
Mao 2020	159	684	29	132	0.85 [0.79, 0.89]	0.16 [0.14, 0.19]		
O'Reilly 2020	4	94	7	135	0.36 [0.11, 0.69]	0.59 [0.52, 0.65]		
Peng 2020	10	54	1	21	0.91 [0.59, 1.00]	0.28 [0.18, 0.40]		
Peyrony 2020	176	83	49	83	0.78 [0.72, 0.83]	0.50 [0.42, 0.58]		
Pisapia 2020	16	20	1	0	0.94 [0.71, 1.00]	0.00 [0.00, 0.17]		
Rentsch 2020	120	169	431	2664	0.22 [0.18, 0.25]	0.94 [0.93, 0.95]		
Shah 2020	15	69	18	214	0.45 [0.28, 0.64]	0.76 [0.70, 0.81]		
Song 2020a	85	844	6	376	0.93 [0.86, 0.98]	0.31 [0.28, 0.33]		
Tolia 2020	2	25	27	227	0.07 [0.01, 0.23]	0.90 [0.86, 0.93]		
Tordjman 2020	46	32	4	18	0.92 [0.81, 0.98]	0.36 [0.23, 0.51]		
Trubiano 2020	56	1063	52	1764	0.52 [0.42, 0.62]	0.62 [0.61, 0.64]		
Wei 2020	491	225	137	83	0.78 [0.75, 0.81]	0.27 [0.22, 0.32]		
Xie 2020	19	68	2	16	0.90 [0.70, 0.99]	0.19 [0.11, 0.29]		
Yombi 2020	109	111	66	250	0.62 [0.55, 0.69]	0.69 [0.64, 0.74]		
Zavascki 2020	76	162	22	204	0.78 [0.68, 0.85]	0.56 [0.50, 0.61]		
Zayet 2020b	70	80	25	42	0.74 [0.64, 0.82]	0.34 [0.26, 0.44]		
Zhu 2020	27	57	5	27	0.84 [0.67, 0.95]	0.32 [0.22, 0.43]		
Zimmerman 2020	47	463	8	218	0.85 [0.73, 0.94]	0.32 [0.29, 0.36]		

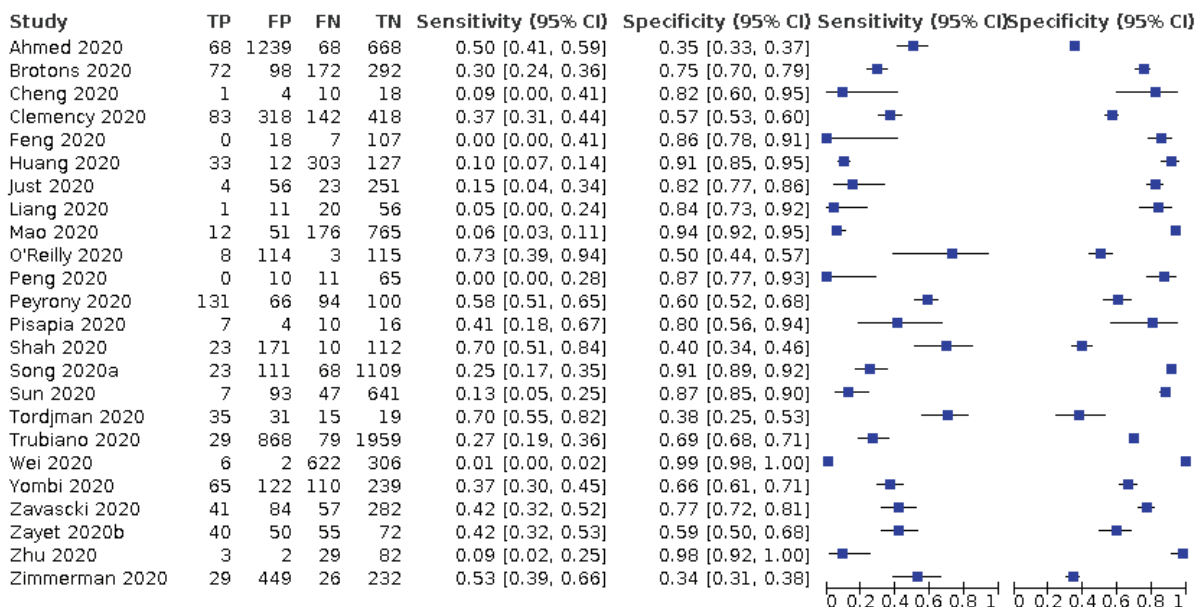
Test 2. Cough

Cough



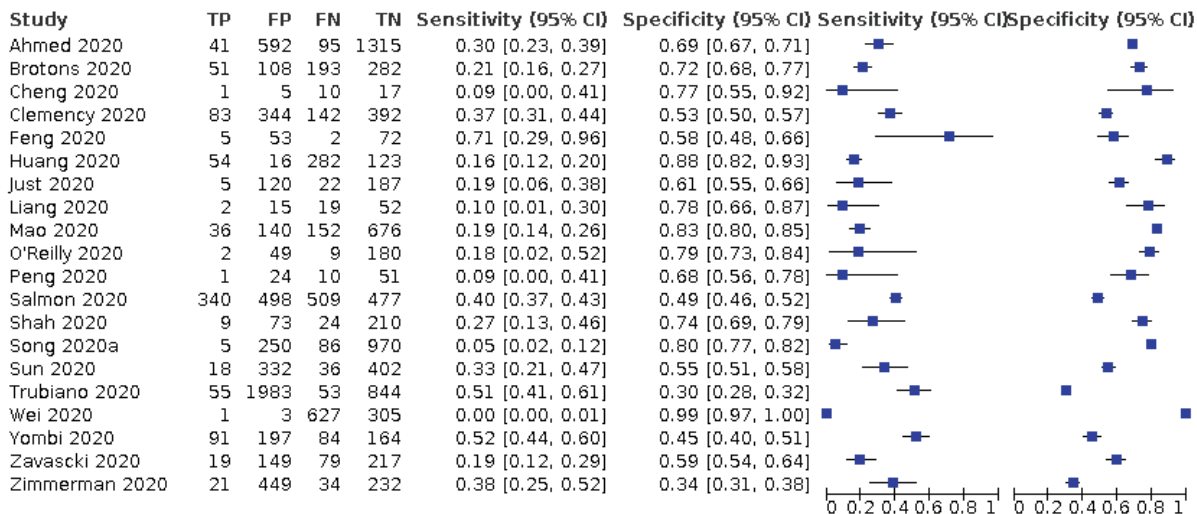
Test 3. Dyspnoea

Dyspnoea



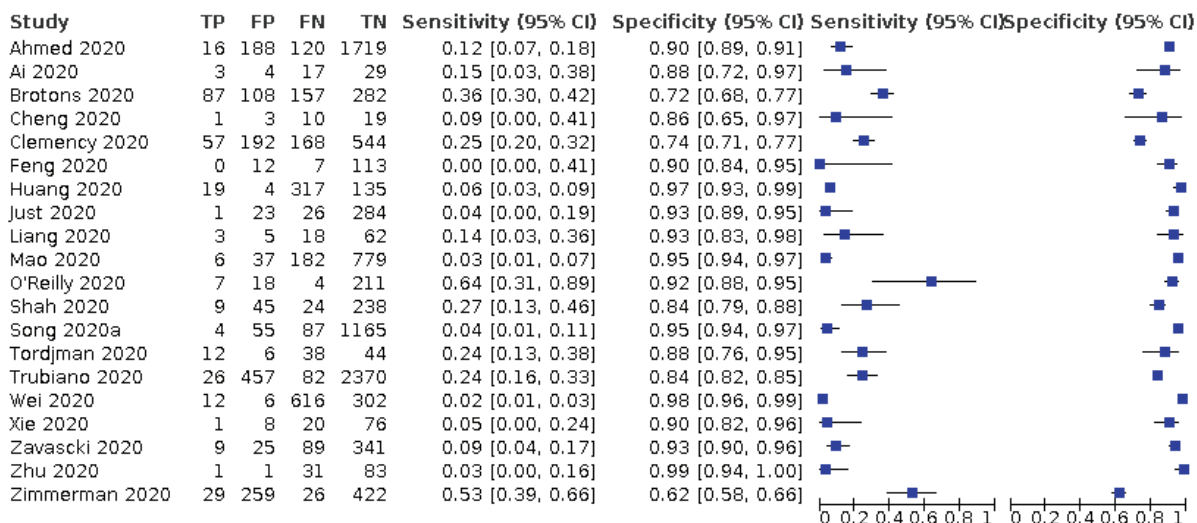
Test 4. Sore throat

Sore throat



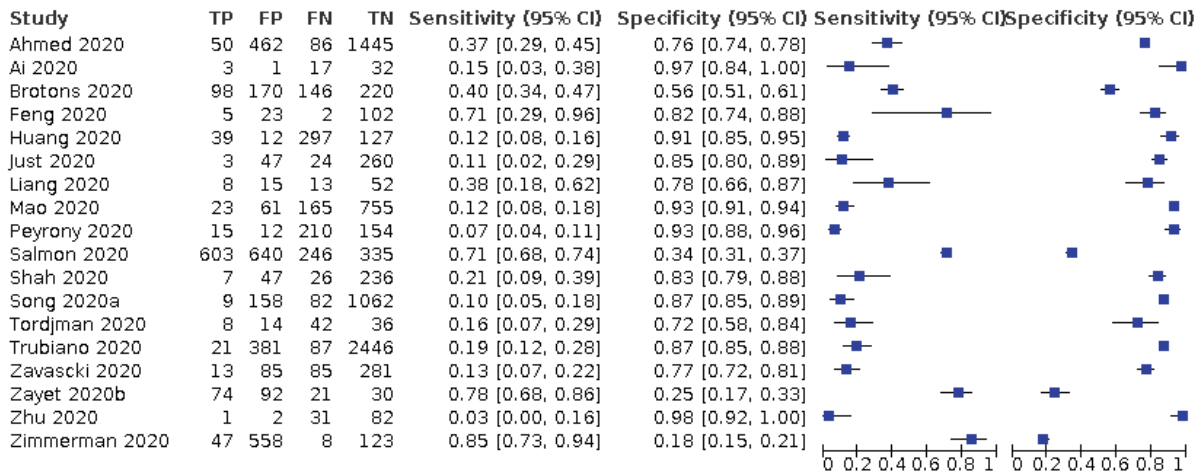
Test 5. Diarrhoea

Diarrhoea



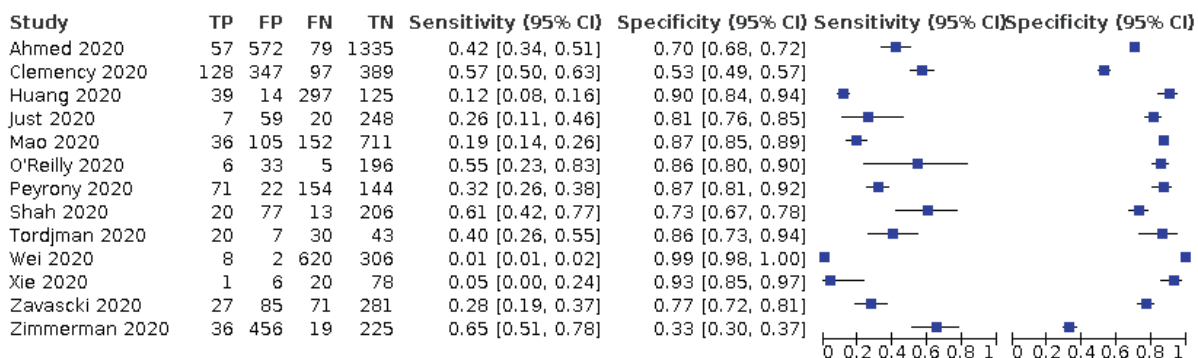
Test 6. Headache

Headache



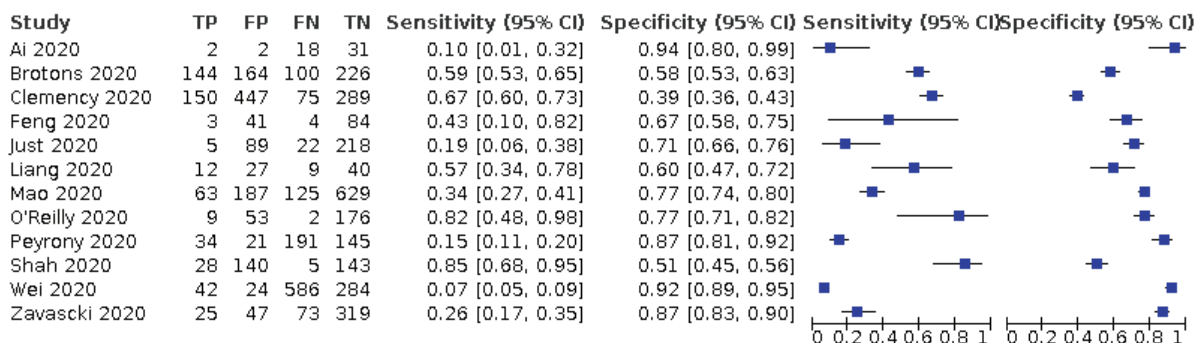
Test 7. Myalgia

Myalgia



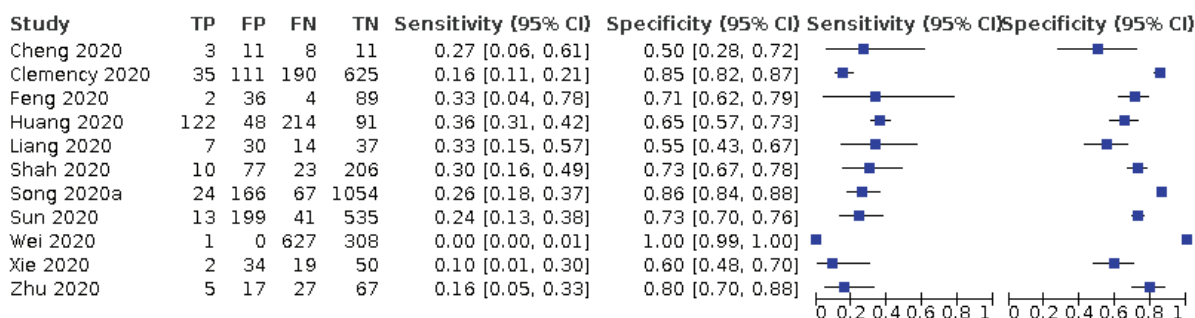
Test 8. Fatigue

Fatigue



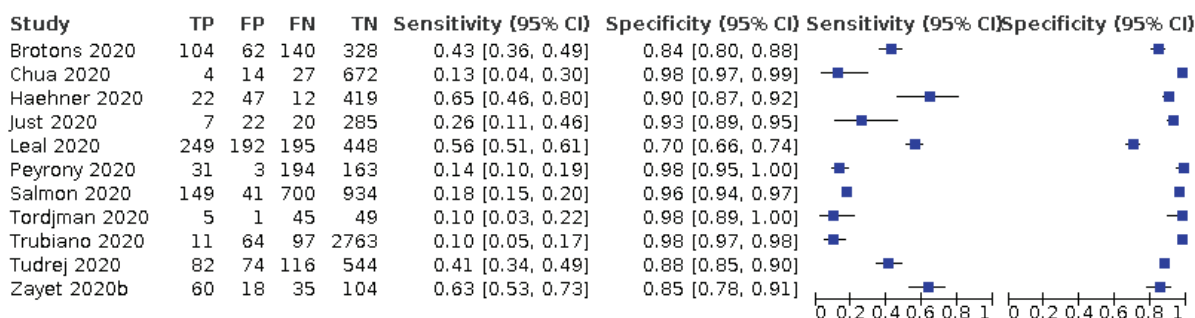
Test 9. Sputum production

Sputum production



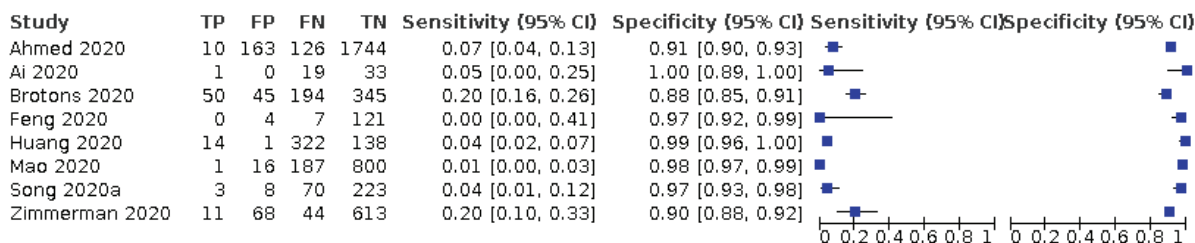
Test 10. Anosmia

Anosmia



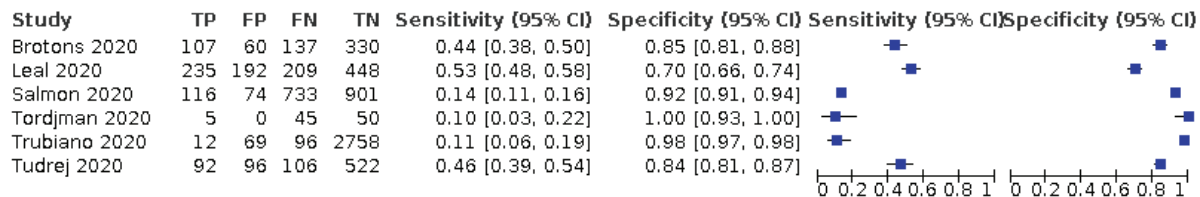
Test 11. Nausea or vomiting

Nausea or vomiting



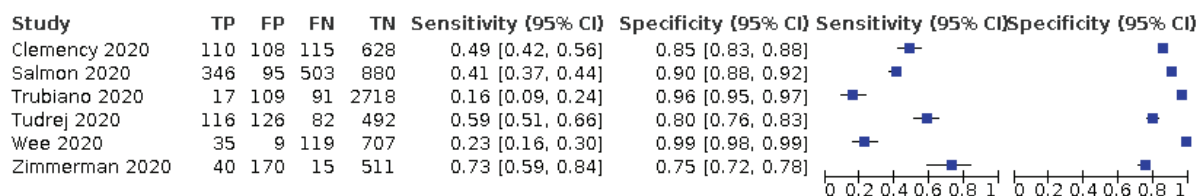
Test 12. Ageusia

Ageusia



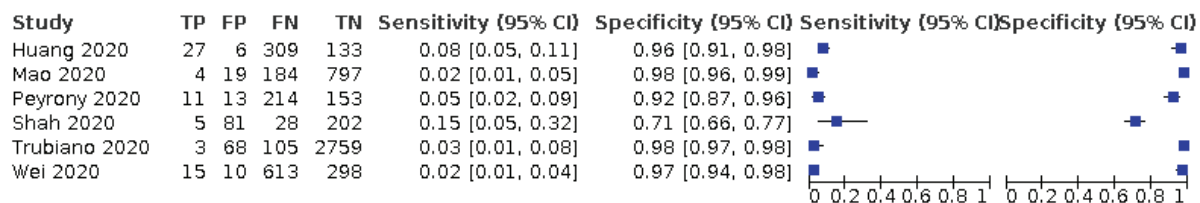
Test 13. Anosmia or ageusia

Anosmia or ageusia



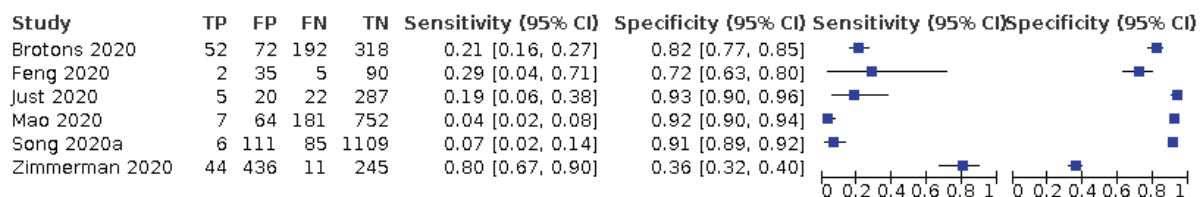
Test 14. Chest tightness

Chest tightness















Test 15. Chills

Chills













Test 16. Nasal congestion

Nasal congestion

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Ahmed 2020	44	562	92	1345	0.32 [0.25, 0.41]	0.71 [0.68, 0.73]		
Huang 2020	11	4	325	135	0.03 [0.02, 0.06]	0.97 [0.93, 0.99]		
Just 2020	5	84	22	223	0.19 [0.06, 0.38]	0.73 [0.67, 0.78]		
Mao 2020	8	32	180	784	0.04 [0.02, 0.08]	0.96 [0.95, 0.97]		
Wei 2020	2	0	626	308	0.00 [0.00, 0.01]	1.00 [0.99, 1.00]		
Zavascki 2020	2	36	96	330	0.02 [0.00, 0.07]	0.90 [0.87, 0.93]		











Test 17. Abdominal pain

Abdominal pain

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Ai 2020	1	0	19	33	0.05 [0.00, 0.25]	1.00 [0.89, 1.00]		
Feng 2020	0	5	7	120	0.00 [0.00, 0.41]	0.96 [0.91, 0.99]		
Mao 2020	0	11	188	805	0.00 [0.00, 0.02]	0.99 [0.98, 0.99]		
Shah 2020	4	26	29	257	0.12 [0.03, 0.28]	0.91 [0.87, 0.94]		
Zimmerman 2020	11	184	44	497	0.20 [0.10, 0.33]	0.73 [0.69, 0.76]		











Test 18. Rhinorrhea

Rhinorrhea

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Huang 2020	14	15	322	124	0.04 [0.02, 0.07]	0.89 [0.83, 0.94]		
Mao 2020	9	59	179	757	0.05 [0.02, 0.09]	0.93 [0.91, 0.94]		
O'Reilly 2020	3	33	8	196	0.27 [0.06, 0.61]	0.86 [0.80, 0.90]		
Shah 2020	10	74	23	209	0.30 [0.16, 0.49]	0.74 [0.68, 0.79]		
Zayet 2020b	59	77	36	45	0.62 [0.52, 0.72]	0.37 [0.28, 0.46]		

Test 19. Myalgia or arthralgia

Myalgia or arthralgia

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Cheng 2020	3	2	8	20	0.27 [0.06, 0.61]	0.91 [0.71, 0.99]		
Feng 2020	6	37	1	88	0.86 [0.42, 1.00]	0.70 [0.62, 0.78]		
Liang 2020	4	17	17	50	0.19 [0.05, 0.42]	0.75 [0.63, 0.84]		
Peng 2020	7	41	4	34	0.64 [0.31, 0.89]	0.45 [0.34, 0.57]		
Zayet 2020b	71	79	24	43	0.75 [0.65, 0.83]	0.35 [0.27, 0.44]		

Test 20. Nasal symptoms

Nasal symptoms

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Feng 2020	1	27	6	98	0.14 [0.00, 0.58]	0.78 [0.70, 0.85]		
Liang 2020	1	10	20	57	0.05 [0.00, 0.24]	0.85 [0.74, 0.93]		
Peng 2020	0	6	11	69	0.00 [0.00, 0.28]	0.92 [0.83, 0.97]		
Song 2020a	1	107	90	1113	0.01 [0.00, 0.06]	0.91 [0.90, 0.93]		
Sun 2020	12	226	42	508	0.22 [0.12, 0.36]	0.69 [0.66, 0.73]		

Test 21. Nausea

Nausea

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Just 2020	0	11	27	296	0.00 [0.00, 0.13]	0.96 [0.94, 0.98]		
Shah 2020	8	48	25	235	0.24 [0.11, 0.42]	0.83 [0.78, 0.87]		
Wei 2020	1	1	627	307	0.00 [0.00, 0.01]	1.00 [0.98, 1.00]		
Zavascki 2020	4	23	94	343	0.04 [0.01, 0.10]	0.94 [0.91, 0.96]		

Test 22. Haemoptysis

Haemoptysis

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Huang 2020	3	0	333	139	0.01 [0.00, 0.03]	1.00 [0.97, 1.00]		
Mao 2020	1	7	187	809	0.01 [0.00, 0.03]	0.99 [0.98, 1.00]		
Peyrony 2020	3	1	222	165	0.01 [0.00, 0.04]	0.99 [0.97, 1.00]		
Zhu 2020	0	1	32	83	0.00 [0.00, 0.11]	0.99 [0.94, 1.00]		

Test 23. Gastrointestinal symptoms (not specified)

Gastrointestinal symptoms (not specified)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Peyrony 2020	53	41	172	125	0.24 [0.18, 0.30]	0.75 [0.68, 0.82]		
Sun 2020	20	238	34	496	0.37 [0.24, 0.51]	0.68 [0.64, 0.71]		
Trubiano 2020	1	62	107	2765	0.01 [0.00, 0.05]	0.98 [0.97, 0.98]		
Zayet 2020b	54	69	41	53	0.57 [0.46, 0.67]	0.43 [0.34, 0.53]		

Test 24. Dry cough

Dry cough

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Clemency 2020	166	500	59	236	0.74 [0.68, 0.79]	0.32 [0.29, 0.36]		
Huang 2020	132	34	204	105	0.39 [0.34, 0.45]	0.76 [0.68, 0.82]		
Shah 2020	12	62	21	221	0.36 [0.20, 0.55]	0.78 [0.73, 0.83]		

Test 25. Vomiting

Vomiting

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Just 2020	0	4	27	303	0.00 [0.00, 0.13]	0.99 [0.97, 1.00]		
Shah 2020	5	28	28	255	0.15 [0.05, 0.32]	0.90 [0.86, 0.93]		
Wei 2020	1	0	627	308	0.00 [0.00, 0.01]	1.00 [0.99, 1.00]		

Test 26. Skin lesions

Skin lesions

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Brottons 2020	23	31	221	359	0.09 [0.06, 0.14]	0.92 [0.89, 0.95]		
Huang 2020	0	0	336	139	0.00 [0.00, 0.01]	1.00 [0.97, 1.00]		
Peyrony 2020	23	11	202	155	0.10 [0.07, 0.15]	0.93 [0.88, 0.97]		

Test 27. Anosmia and ageusia

Anosmia and ageusia

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Salmon 2020	314	66	535	909	0.37 [0.34, 0.40]	0.93 [0.91, 0.95]		
Tudrej 2020	58	44	140	574	0.29 [0.23, 0.36]	0.93 [0.91, 0.95]		

Test 28. Anosmia or dysgeusia

Anosmia or dysgeusia

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
O'Reilly 2020	1	7	10	222	0.09 [0.00, 0.41]	0.97 [0.94, 0.99]		
Zayet 2020b	70	27	25	95	0.74 [0.64, 0.82]	0.78 [0.69, 0.85]		

Test 29. Anorexia

Anorexia

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Just 2020	2	28	25	279	0.07 [0.01, 0.24]	0.91 [0.87, 0.94]		
Wei 2020	3	4	625	304	0.00 [0.00, 0.01]	0.99 [0.97, 1.00]		

Test 30. Coryza

Coryza

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Trubiano 2020	47	1559	61	1268	0.44 [0.34, 0.53]	0.45 [0.43, 0.47]		
Zavascki 2020	11	121	87	245	0.11 [0.06, 0.19]	0.67 [0.62, 0.72]		

Test 31. Wheeze

Wheeze

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Huang 2020	15	10	321	129	0.04 [0.03, 0.07]	0.93 [0.87, 0.96]		
Peyrony 2020	4	13	221	153	0.02 [0.00, 0.04]	0.92 [0.87, 0.96]		

Test 32. Myalgia or fatigue

Myalgia or fatigue

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Song 2020a	28	214	63	1006	0.31 [0.22, 0.41]	0.82 [0.80, 0.85]		
Zhu 2020	5	6	27	78	0.16 [0.05, 0.33]	0.93 [0.85, 0.97]		

Test 33. Fever (subjective)

Fever (subjective)

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Shah 2020	27	125	6	158	0.82 [0.65, 0.93]	0.56 [0.50, 0.62]		
Trubiano 2020	46	859	62	1968	0.43 [0.33, 0.52]	0.70 [0.68, 0.71]		

Test 34. High fever (>=38.5°C)

High fever (>=38.5°C)

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Mao 2020	33	234	155	582	0.18 [0.12, 0.24]	0.71 [0.68, 0.74]		
Trubiano 2020	14	260	94	2567	0.13 [0.07, 0.21]	0.91 [0.90, 0.92]		

Test 35. Altered mentation

Altered mentation

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Peyrony 2020	15	13	210	153	0.07 [0.04, 0.11]	0.92 [0.87, 0.96]		
Shah 2020	2	39	31	244	0.06 [0.01, 0.20]	0.86 [0.82, 0.90]		

Test 36. Weakness or fatigue

Weakness or fatigue

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Huang 2020	83	15	253	124	0.25 [0.20, 0.30]	0.89 [0.83, 0.94]		
Xie 2020	4	14	17	70	0.19 [0.05, 0.42]	0.83 [0.74, 0.91]		

Test 37. Tachycardia

Tachycardia

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Rentsch 2020	257	1083	295	1738	0.47 [0.42, 0.51]	0.62 [0.60, 0.63]		
Shah 2020	16	164	17	119	0.48 [0.31, 0.66]	0.42 [0.36, 0.48]		

Test 38. Loss of appetite

Loss of appetite

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Clemency 2020	90	194	135	542	0.40 [0.34, 0.47]	0.74 [0.70, 0.77]		
Mao 2020	24	55	164	761	0.13 [0.08, 0.18]	0.93 [0.91, 0.95]		

Test 39. Hypoxia

Hypoxia

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Rentsch 2020	78	418	443	1990	0.15 [0.12, 0.18]	0.83 [0.81, 0.84]		

Test 41. Respiratory symptoms (not specified))

Respiratory symptoms (not specified))

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Sun 2020	2	43	52	691	0.04 [0.00, 0.13]	0.94 [0.92, 0.96]		

Test 42. Rhinitis or pharyngitis

Rhinitis or pharyngitis

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Peyrony 2020	19	26	206	140	0.08 [0.05, 0.13]	0.84 [0.78, 0.90]		

Test 43. Sinusitis

Sinusitis

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Trubiano 2020	1	13	107	2814	0.01 [0.00, 0.05]	1.00 [0.99, 1.00]		

Test 44. Isolated fever

Isolated fever

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Gilbert 2020	5	7	170	416	0.03 [0.01, 0.07]	0.98 [0.97, 0.99]		

Test 45. Low body temperature

Low body temperature

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Rentsch 2020	204	1938	347	895	0.37 [0.33, 0.41]	0.32 [0.30, 0.33]		

Test 46. Shivers

Shivers

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Feng 2020	1	17	6	108	0.14 [0.00, 0.58]	0.86 [0.79, 0.92]		

Test 47. Arthralgia

Arthralgia

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Pisapia 2020	3	3	14	17	0.18 [0.04, 0.43]	0.85 [0.62, 0.97]		

Test 48. Systemic soreness (malaise/myalgia/arthralgia)

Systemic soreness (malaise/myalgia/arthralgia)

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Trubiano 2020	71	1339	37	1488	0.66 [0.56, 0.75]	0.53 [0.51, 0.54]		

Test 49. Abdominal distension

Abdominal distension

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Wei 2020	0	1	628	307	0.00 [0.00, 0.01]	1.00 [0.98, 1.00]		

Test 50. Low systolic blood pressure

Low systolic blood pressure

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Rentsch 2020	63	292	485	2501	0.11 [0.09, 0.14]	0.90 [0.88, 0.91]		

Test 51. High systolic blood pressure

High systolic blood pressure

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Rentsch 2020	211	1210	337	1583	0.39 [0.34, 0.43]	0.57 [0.55, 0.59]		

Test 52. Palpitations

Palpitations

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Feng 2020	0	3	7	122	0.00 [0.00, 0.41]	0.98 [0.93, 1.00]		

Test 53. Tachypnea

Tachypnea

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Shah 2020	13	124	20	159	0.39 [0.23, 0.58]	0.56 [0.50, 0.62]		

Test 54. Lethargy

Lethargy

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Ahmed 2020	43	496	93	141	0.32 [0.24, 0.40]	0.22 [0.19, 0.26]		

Test 55. Hyposmia

Hyposmia

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Chua 2020	3	8	28	678	0.10 [0.02, 0.26]	0.99 [0.98, 0.99]		

Test 56. Dysgeusia

Dysgeusia

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Zayet 2020b	62	19	33	103	0.65 [0.55, 0.75]	0.84 [0.77, 0.90]		

Test 57. Anosmia and dysgeusia

Anosmia and dysgeusia

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Zayet 2020b	52	11	43	111	0.55 [0.44, 0.65]	0.91 [0.84, 0.95]		

Test 58. Rash

Rash

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Huang 2020	2	0	334	139	0.01 [0.00, 0.02]	1.00 [0.97, 1.00]		

Test 59. Isolated headache

Isolated headache

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Gilbert 2020	0	3	175	420	0.00 [0.00, 0.02]	0.99 [0.98, 1.00]		

Test 60. Diarrhea and nausea

Diarrhea and nausea

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Gilbert 2020	0	3	175	420	0.00 [0.00, 0.02]	0.99 [0.98, 1.00]		

Test 61. Dizziness or syncope

Dizziness or syncope

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Peyrony 2020	8	13	217	153	0.04 [0.02, 0.07]	0.92 [0.87, 0.96]		

Test 62. Earache

Earache

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Huang 2020	1	0	335	139	0.00 [0.00, 0.02]	1.00 [0.97, 1.00]		

Test 63. Enlargement of lymph nodes

Enlargement of lymph nodes

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Huang 2020	0	2	336	137	0.00 [0.00, 0.01]	0.99 [0.95, 1.00]		

Test 64. Stomachache

Stomachache

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Huang 2020	6	2	330	137	0.02 [0.01, 0.04]	0.99 [0.95, 1.00]		

Test 65. Arthralgia

Arthralgia

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Huang 2020	6	3	330	136	0.02 [0.01, 0.04]	0.98 [0.94, 1.00]		

Test 66. Unconsciousness

Unconsciousness

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Huang 2020	1	0	335	139	0.00 [0.00, 0.02]	1.00 [0.97, 1.00]		

Test 67. Aversion to cold

Aversion to cold

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Wei 2020	1	1	627	307	0.00 [0.00, 0.01]	1.00 [0.98, 1.00]		

Test 68. Xerostomia

Xerostomia

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Wei 2020	1	0	627	308	0.00 [0.00, 0.01]	1.00 [0.99, 1.00]		

Test 69. Hypersomnia

Hypersomnia

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Wei 2020	1	0	627	308	0.00 [0.00, 0.01]	1.00 [0.99, 1.00]		

Test 70. Sneezing

Sneezing

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Mao 2020	2	2	186	814	0.01 [0.00, 0.04]	1.00 [0.99, 1.00]		

Test 71. Change to chronic cough

Change to chronic cough

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
O'Reilly 2020	1	14	10	215	0.09 [0.00, 0.41]	0.94 [0.90, 0.97]		

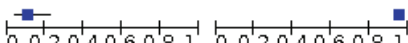
Test 72. Dizziness

Dizziness

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Wei 2020	1	0	627	308	0.00 [0.00, 0.01]	1.00 [0.99, 1.00]		

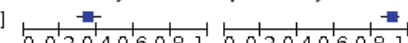
Test 73. Positive auscultation findings

Positive auscultation findings

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Sun 2020	6	36	48	698	0.11 [0.04, 0.23]	0.95 [0.93, 0.97]		

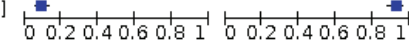
Test 74. Pulmonary auscultation: crackling bilateral

Pulmonary auscultation: crackling bilateral

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Peyrony 2020	80	15	145	151	0.36 [0.29, 0.42]	0.91 [0.86, 0.95]		

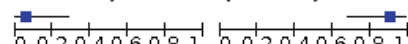
Test 75. Pulmonary auscultation: crackling unilateral

Pulmonary auscultation: crackling unilateral

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Peyrony 2020	21	12	204	154	0.09 [0.06, 0.14]	0.93 [0.88, 0.96]		

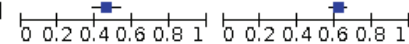
Test 76. Conjunctivitis

Conjunctivitis

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Pisapia 2020	1	2	16	18	0.06 [0.00, 0.29]	0.90 [0.68, 0.99]		

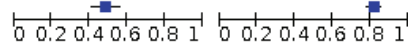
Test 77. Myalgia and asthenia and fever

Myalgia and asthenia and fever

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Gilbert 2020	81	162	94	261	0.46 [0.39, 0.54]	0.62 [0.57, 0.66]		

Test 78. Fever and cough

Fever and cough

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Yombi 2020	85	65	90	296	0.49 [0.41, 0.56]	0.82 [0.78, 0.86]		

Test 79. Fever and cough and sore throat

Fever and cough and sore throat

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Yombi 2020	48	44	127	317	0.27 [0.21, 0.35]	0.88 [0.84, 0.91]		

Test 80. Fever and cough and dyspnea

Fever and cough and dyspnea

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Yombi 2020	33	31	142	330	0.19 [0.13, 0.25]	0.91 [0.88, 0.94]		

Test 81. Cough and fever and sputum production

Cough and fever and sputum production

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Gilbert 2020	37	81	138	342	0.21 [0.15, 0.28]	0.81 [0.77, 0.84]		

Test 82. Cough and fever and sputum production and dyspnea

Cough and fever and sputum production and dyspnea

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Gilbert 2020	21	27	154	396	0.12 [0.08, 0.18]	0.94 [0.91, 0.96]		

Test 83. Sore throat and nasal congestion and sneezing and mild fever

Sore throat and nasal congestion and sneezing and mild fever

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Gilbert 2020	18	109	157	314	0.10 [0.06, 0.16]	0.74 [0.70, 0.78]		

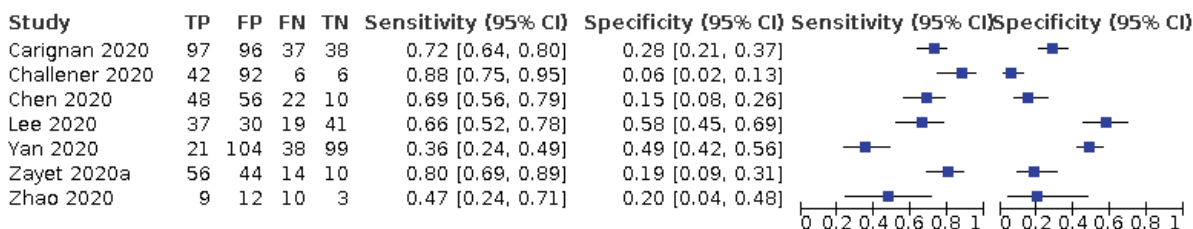
Test 84. Dyspnea and cough and fever and low oxygen saturation

Dyspnea and cough and fever and low oxygen saturation

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Gilbert 2020	5	9	170	414	0.03 [0.01, 0.07]	0.98 [0.96, 0.99]		

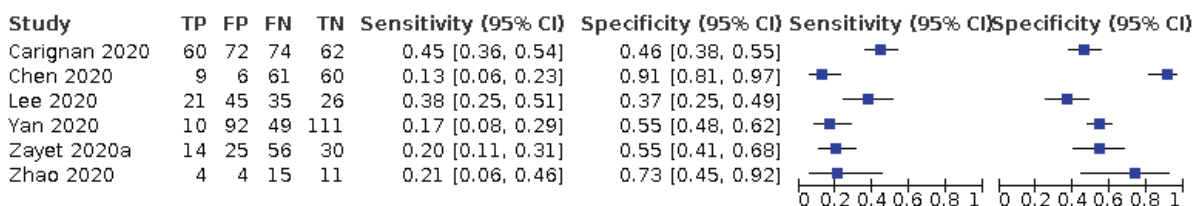
Test 85. Cough (non-cross-sectional study)

Cough (non-cross-sectional study)



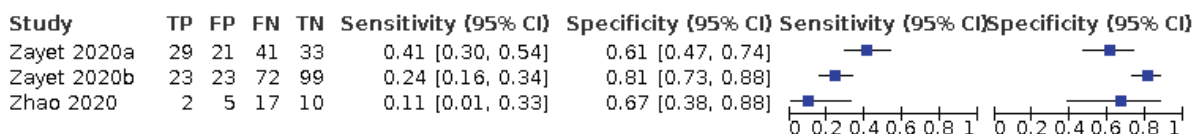
Test 86. Sore throat (non-cross-sectional study)

Sore throat (non-cross-sectional study)



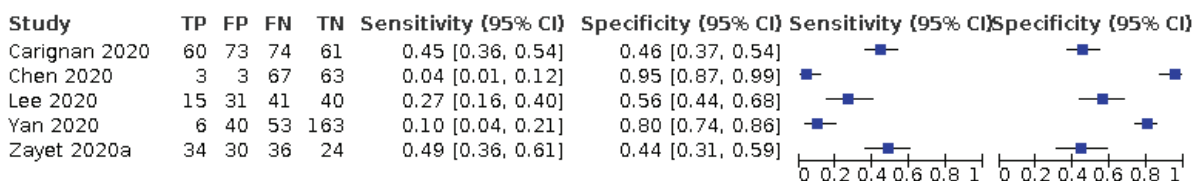
Test 87. Positive auscultation findings (non-cross-sectional study)

Positive auscultation findings (non-cross-sectional study)









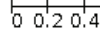

Test 88. Rhinorrhoea (non-cross-sectional study)

Rhinorrhoea (non-cross-sectional study)





Test 89. Dyspnoea (non-cross-sectional study)

Dyspnoea (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Carignan 2020	56	49	78	85	0.42 [0.33, 0.51]	0.63 [0.55, 0.72]		
Lee 2020	21	19	35	52	0.38 [0.25, 0.51]	0.73 [0.61, 0.83]		
Yan 2020	7	47	52	156	0.12 [0.05, 0.23]	0.77 [0.70, 0.82]		
Zayet 2020a	24	32	46	22	0.34 [0.23, 0.47]	0.41 [0.28, 0.55]		







Test 90. Ageusia (non-cross-sectional study)

Ageusia (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Yan 2020	12	10	47	193	0.20 [0.11, 0.33]	0.95 [0.91, 0.98]		











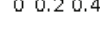

Test 91. Chest tightness (non-cross-sectional study)

Chest tightness (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Carignan 2020	35	30	99	104	0.26 [0.19, 0.34]	0.78 [0.70, 0.84]		
Zayet 2020a	18	10	52	44	0.26 [0.16, 0.38]	0.81 [0.69, 0.91]		
Zhao 2020	1	0	18	15	0.05 [0.00, 0.26]	1.00 [0.78, 1.00]		









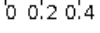

Test 92. Fever (non-cross-sectional study)

Fever (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Carignan 2020	50	20	84	114	0.37 [0.29, 0.46]	0.85 [0.78, 0.91]		
Challener 2020	36	83	12	15	0.75 [0.60, 0.86]	0.15 [0.09, 0.24]		
Lee 2020	26	19	30	52	0.46 [0.33, 0.60]	0.73 [0.61, 0.83]		
Yan 2020	32	53	27	150	0.54 [0.41, 0.67]	0.74 [0.67, 0.80]		
Zayet 2020a	53	50	17	4	0.76 [0.64, 0.85]	0.07 [0.02, 0.18]		
Zhao 2020	15	14	4	1	0.79 [0.54, 0.94]	0.07 [0.00, 0.32]		

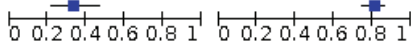
Test 93. Fatigue (non-cross-sectional study)

Fatigue (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Chen 2020	22	8	48	58	0.31 [0.21, 0.44]	0.88 [0.78, 0.95]		
Lee 2020	4	11	52	60	0.07 [0.02, 0.17]	0.85 [0.74, 0.92]		
Yan 2020	25	62	34	141	0.42 [0.30, 0.56]	0.69 [0.63, 0.76]		
Zayet 2020a	65	47	5	7	0.93 [0.84, 0.98]	0.13 [0.05, 0.25]		
Zhao 2020	2	0	17	15	0.11 [0.01, 0.33]	1.00 [0.78, 1.00]		




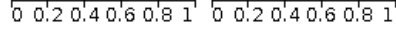

Test 94. Myalgia or arthralgia (non-cross-sectional study)

Myalgia or arthralgia (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Yan 2020	20	39	39	164	0.34 [0.22, 0.47]	0.81 [0.75, 0.86]		




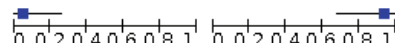
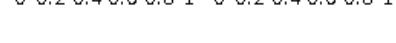

Test 95. Headache (non-cross-sectional study)

Headache (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Carignan 2020	87	62	47	72	0.65 [0.56, 0.73]	0.54 [0.45, 0.62]		
Lee 2020	10	4	46	67	0.18 [0.09, 0.30]	0.94 [0.86, 0.98]		
Yan 2020	25	40	34	163	0.42 [0.30, 0.56]	0.80 [0.74, 0.86]		
Zayet 2020a	51	31	19	23	0.73 [0.61, 0.83]	0.43 [0.29, 0.57]		
Zhao 2020	2	0	17	15	0.11 [0.01, 0.33]	1.00 [0.78, 1.00]		

Test 96. Diarrhoea (non-cross-sectional study)

Diarrhoea (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Carignan 2020	60	31	74	103	0.45 [0.36, 0.54]	0.77 [0.69, 0.84]		
Lee 2020	20	13	36	58	0.36 [0.23, 0.50]	0.82 [0.71, 0.90]		
Nobel 2020	56	36	222	202	0.20 [0.16, 0.25]	0.85 [0.80, 0.89]		
Yan 2020	5	16	54	187	0.08 [0.03, 0.19]	0.92 [0.88, 0.95]		
Zayet 2020a	28	11	42	43	0.40 [0.28, 0.52]	0.80 [0.66, 0.89]		
Zhao 2020	1	1	18	14	0.05 [0.00, 0.26]	0.93 [0.68, 1.00]		

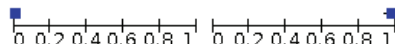
Test 97. Nausea/vomiting (non-cross-sectional study)

Nausea/vomiting (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Nobel 2020	63	46	215	192	0.23 [0.18, 0.28]	0.81 [0.75, 0.85]		

Test 98. Red eyes (non-cross-sectional study)

Red eyes (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Carignan 2020	1	3	133	131	0.01 [0.00, 0.04]	0.98 [0.94, 1.00]		

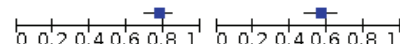
Test 99. Gastrointestinal symptoms, not specified (non-cross-sectional study)

Gastrointestinal symptoms, not specified (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Nobel 2020	97	63	181	175	0.35 [0.29, 0.41]	0.74 [0.67, 0.79]		


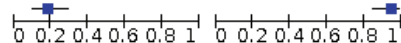
Test TST-100. Asthenia (non-cross-sectional study)

Asthenia (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Carignan 2020	104	58	30	76	0.78 [0.70, 0.84]	0.57 [0.48, 0.65]		


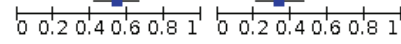
Test TST-101. Fever (subjective, non-cross-sectional study)

Fever (subjective, non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Carignan 2020	46	35	88	99	0.34 [0.26, 0.43]	0.74 [0.66, 0.81]		
Lee 2020	0	0	0	0	Not estimable	Not estimable		
Zayet 2020a	13	3	57	51	0.19 [0.10, 0.30]	0.94 [0.85, 0.99]		


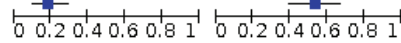
Test TST-102. Arthralgia (non-cross-sectional study)

Arthralgia (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Carignan 2020	37	19	97	115	0.28 [0.20, 0.36]	0.86 [0.79, 0.91]		
Zayet 2020a	38	36	32	18	0.54 [0.42, 0.66]	0.33 [0.21, 0.47]		

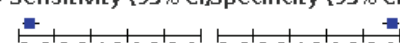
Test TST-103. Sneezing (non-cross-sectional study)

Sneezing (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Carignan 2020	53	58	81	76	0.40 [0.31, 0.48]	0.57 [0.48, 0.65]		
Zayet 2020a	13	25	57	29	0.19 [0.10, 0.30]	0.54 [0.40, 0.67]		

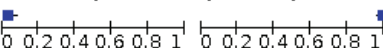
Test TST-104. Rash (non-cross-sectional study)

Rash (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Carignan 2020	8	6	126	128	0.06 [0.03, 0.11]	0.96 [0.91, 0.98]		

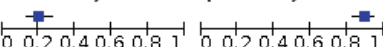
Test TST-105. Loss of temp. sens. in face (non-cross-sectional study)

Loss of temp. sens. in face (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Carignan 2020	5	1	129	133	0.04 [0.01, 0.08]	0.99 [0.96, 1.00]		


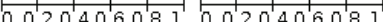
Test TST-106. Vertigo or dizziness (non-cross-sectional study)

Vertigo or dizziness (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Carignan 2020	27	14	107	120	0.20 [0.14, 0.28]	0.90 [0.83, 0.94]		



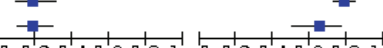
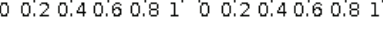

Test TST-107. Blurred vision (non-cross-sectional study)

Blurred vision (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Carignan 2020	6	9	128	125	0.04 [0.02, 0.09]	0.93 [0.88, 0.97]		
Zayet 2020a	3	1	67	53	0.04 [0.01, 0.12]	0.98 [0.90, 1.00]		

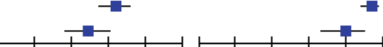
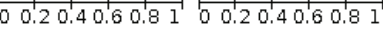
Test TST-108. Nasal congestion (non-cross-sectional study)

Nasal congestion (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Carignan 2020	58	56	76	78	0.43 [0.35, 0.52]	0.58 [0.49, 0.67]		
Chen 2020	2	4	68	62	0.03 [0.00, 0.10]	0.94 [0.85, 0.98]		
Lee 2020	23	27	33	44	0.41 [0.28, 0.55]	0.62 [0.50, 0.73]		
Yan 2020	11	43	48	160	0.19 [0.10, 0.31]	0.79 [0.73, 0.84]		
Zayet 2020a	13	19	57	35	0.19 [0.10, 0.30]	0.65 [0.51, 0.77]		

Test TST-109. Dysgeusia (non-cross-sectional study)

Dysgeusia (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Carignan 2020	85	9	49	125	0.63 [0.55, 0.72]	0.93 [0.88, 0.97]		
Zayet 2020a	34	11	36	43	0.49 [0.36, 0.61]	0.80 [0.66, 0.89]		

Test TST-110. Anosmia (non-cross-sectional study)

Anosmia (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Carignan 2020	69	6	65	128	0.51 [0.43, 0.60]	0.96 [0.91, 0.98]		
Lee 2020	24	2	32	69	0.43 [0.30, 0.57]	0.97 [0.90, 1.00]		
Yan 2020	13	9	46	194	0.22 [0.12, 0.35]	0.96 [0.92, 0.98]		
Zayet 2020a	37	9	33	45	0.53 [0.41, 0.65]	0.83 [0.71, 0.92]		

Test TST-111. Loss of appetite (non-cross-sectional study)

Loss of appetite (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Carignan 2020	75	26	59	108	0.56 [0.47, 0.65]	0.81 [0.73, 0.87]		

Test TST-112. Myalgia (non-cross-sectional study)

Myalgia (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Carignan 2020	76	29	58	105	0.57 [0.48, 0.65]	0.78 [0.70, 0.85]		
Zayet 2020a	41	38	29	16	0.59 [0.46, 0.70]	0.30 [0.18, 0.44]		

Test TST-113. Anosmia or dysgeusia (non-cross-sectional study)

Anosmia or dysgeusia (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Carignan 2020	87	11	47	123	0.65 [0.56, 0.73]	0.92 [0.86, 0.96]		

Test TST-114. Sputum production (non-cross-sectional study)

Sputum production (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Carignan 2020	40	43	94	91	0.30 [0.22, 0.38]	0.68 [0.59, 0.76]		
Zayet 2020a	20	28	50	26	0.29 [0.18, 0.41]	0.48 [0.34, 0.62]		

Test TST-115. Chills (non-cross-sectional study)

Chills (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity {95% CI}	Specificity {95% CI}	Sensitivity {95% CI}	Specificity {95% CI}
Carignan 2020	71	32	63	102	0.53 [0.44, 0.62]	0.76 [0.68, 0.83]		

Test TST-116. Nausea (non-cross-sectional study)

Nausea (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Carignan 2020	40	17	94	117	0.30 [0.22, 0.38]	0.87 [0.80, 0.92]		
Yan 2020	3	8	56	195	0.05 [0.01, 0.14]	0.96 [0.92, 0.98]		
Zayet 2020a	22	11	48	43	0.31 [0.21, 0.44]	0.80 [0.66, 0.89]		

Test TST-117. Vomiting (non-cross-sectional study)

Vomiting (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Carignan 2020	9	5	125	129	0.07 [0.03, 0.12]	0.96 [0.92, 0.99]		
Zayet 2020a	2	12	68	42	0.03 [0.00, 0.10]	0.78 [0.64, 0.88]		

Test TST-119. Abdominal pain (non-cross-sectional study)

Abdominal pain (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Lee 2020	7	6	49	65	0.13 [0.05, 0.24]	0.92 [0.83, 0.97]		
Zayet 2020a	14	9	56	45	0.20 [0.11, 0.31]	0.83 [0.71, 0.92]		

Test TST-120. Conjunctival hyperemia (non-cross-sectional study)

Conjunctival hyperemia (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zayet 2020a	3	16	67	38	0.04 [0.01, 0.12]	0.70 [0.56, 0.82]		

Test TST-121. Diffuse headache (non-cross-sectional study)

Diffuse headache (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zayet 2020a	20	24	50	30	0.29 [0.18, 0.41]	0.56 [0.41, 0.69]		

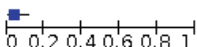
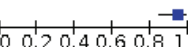
Test TST-122. Frontal headache (non-cross-sectional study)

Frontal headache (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zayet 2020a	18	5	52	49	0.26 [0.16, 0.38]	0.91 [0.80, 0.97]		

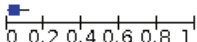
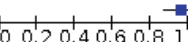
Test TST-123. Epistaxis (non-cross-sectional study)

Epistaxis (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zayet 2020a	3	3	67	51	0.04 [0.01, 0.12]	0.94 [0.85, 0.99]		

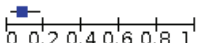
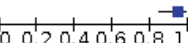
Test TST-124. Dry eyes (non-cross-sectional study)

Dry eyes (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zayet 2020a	3	2	67	52	0.04 [0.01, 0.12]	0.96 [0.87, 1.00]		

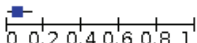
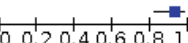
Test TST-125. Haemoptysis (non-cross-sectional study)

Haemoptysis (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zayet 2020a	6	3	64	51	0.09 [0.03, 0.18]	0.94 [0.85, 0.99]		

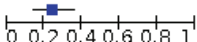
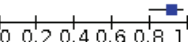
Test TST-126. Hearing loss (non-cross-sectional study)

Hearing loss (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zayet 2020a	4	4	66	50	0.06 [0.02, 0.14]	0.93 [0.82, 0.98]		

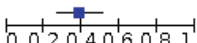
Test TST-127. Pulmonary auscultation: crackling bilateral (non-cross-sectional study)

Pulmonary auscultation: crackling bilateral (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zayet 2020a	17	5	53	49	0.24 [0.15, 0.36]	0.91 [0.80, 0.97]		

Test TST-128. Pulmonary auscultation: crackling unilateral (non-cross-sectional study)

Pulmonary auscultation: crackling unilateral (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zayet 2020a	27	11	43	43	0.39 [0.27, 0.51]	0.80 [0.66, 0.89]		

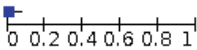
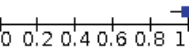
Test TST-129. Pulmonary auscultation: rhonchi (non-cross-sectional study)

Pulmonary auscultation: rhonchi (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zayet 2020a	1	9	69	45	0.01 [0.00, 0.08]	0.83 [0.71, 0.92]		

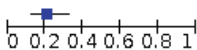
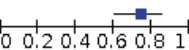
Test TST-130. Pulmonary auscultation: sibilant (non-cross-sectional study)

Pulmonary auscultation: sibilant (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zayet 2020a	1	1	69	53	0.01 [0.00, 0.08]	0.98 [0.90, 1.00]		

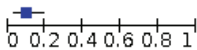
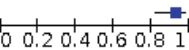
Test TST-131. Tachypnea (non-cross-sectional study)

Tachypnea (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zayet 2020a	15	14	55	40	0.21 [0.13, 0.33]	0.74 [0.60, 0.85]		

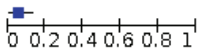
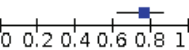
Test TST-132. Tinnitus (non-cross-sectional study)

Tinnitus (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zayet 2020a	7	4	63	50	0.10 [0.04, 0.20]	0.93 [0.82, 0.98]		


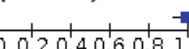
Test TST-133. Tearing (non-cross-sectional study)

Tearing (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Zayet 2020a	4	13	66	41	0.06 [0.02, 0.14]	0.76 [0.62, 0.87]		

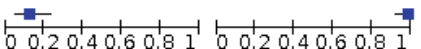
Test TST-134. Dysgeusia or ageusia (non-cross-sectional study)

Dysgeusia or ageusia (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Lee 2020	32	1	24	70	0.57 [0.43, 0.70]	0.99 [0.92, 1.00]		

Test TST-135. Hyposmia (non-cross-sectional study)

Hyposmia (non-cross-sectional study)

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Lee 2020	7	1	49	70	0.13 [0.05, 0.24]	0.99 [0.92, 1.00]		

ADDITIONAL TABLES

Table 1. QUADAS-2 checklist

Index test(s)	Signs and symptoms
Patients (setting, intended use of index test, presentation, prior testing)	<p>Primary care, hospital outpatient settings including emergency departments</p> <p>Inpatients presenting with suspected COVID-19</p> <p>No prior testing</p> <p>Signs and symptoms often used for triage or referral</p>
Reference standard and target condition	The focus will be on the diagnosis of COVID-19 disease and COVID-19 pneumonia. For this review, the focus will not be on prognosis.
Participant selection	
Was a consecutive or random sample of patients enrolled?	<p>This will be similar for all index tests, target conditions, and populations.</p> <p>YES: if a study explicitly stated that all participants within a certain time frame were included; that this was done consecutively; or that a random selection was done.</p> <p>NO: if it was clear that a different selection procedure was employed; for example, selection based on clinician's preference, or based on institutions.</p> <p>UNCLEAR: if the selection procedure was not clear or not reported.</p>
Was a case-control design avoided?	<p>This will be similar for all index tests, target conditions, and populations.</p> <p>YES: if a study explicitly stated that all participants came from the same group of (suspected) patients.</p> <p>NO: if it was clear that a different selection procedure was employed for the participants depending on their COVID-19 (pneumonia) status or SARS-CoV-2 infection status.</p> <p>UNCLEAR: if the selection procedure was not clear or not reported.</p>
Did the study avoid inappropriate exclusions?	<p>Studies may have excluded participants, or selected participants in such a way that they avoided including those who were difficult to diagnose or likely to be borderline. Although the inclusion and exclusion criteria will be different for the different index tests, inappropriate exclusions and inclusions will be similar for all index tests: for example, only elderly patients excluded, or children (as sampling may be more difficult). This needs to be addressed on a case-by-case basis.</p> <p>YES: if a high proportion of eligible patients was included without clear selection.</p> <p>NO: if a high proportion of eligible patients was excluded without providing a reason; if, in a retrospective study, participants without index test or reference standard results were excluded; if exclusion was based on severity assessment post-factum or comorbidities (cardiovascular disease, diabetes, immunosuppression).</p>

Table 1. QUADAS-2 checklist (Continued)

	UNCLEAR: if the exclusion criteria were not reported.
Did the study avoid inappropriate inclusions?	<p>YES: if samples included were likely to be representative of the spectrum of disease.</p> <p>NO: if the study oversampled patients with particular characteristics likely to affect estimates of accuracy.</p> <p>UNCLEAR: if the exclusion criteria were not reported.</p>
Could the selection of patients have introduced bias?	<p>HIGH: if one or more signalling questions were answered with NO, as any deviation from the selection process may lead to bias.</p> <p>LOW: if all signalling questions were answered with YES.</p> <p>UNCLEAR: all other instances.</p>
Is there concern that the included patients do not match the review question?	<p>HIGH: if accuracy of signs and symptoms were assessed in a case-control design, or in an already highly selected group of participants, or the study was able to only estimate sensitivity or specificity.</p> <p>LOW: any situation where signs and symptoms were the first assessment/test to be done on the included participants.</p> <p>UNCLEAR: if a description about the participants was lacking.</p>
Index tests	
Were the index test results interpreted without knowledge of the results of the reference standard?	<p>This will be similar for all index tests, target conditions, and populations.</p> <p>YES: if blinding was explicitly stated or index test was recorded before the results from the reference standard were available.</p> <p>NO: if it was explicitly stated that the index test results were interpreted with knowledge of the results of the reference standard.</p> <p>UNCLEAR: if blinding was unclearly reported.</p>
If a threshold was used, was it prespecified?	<p>This will be similar for all index tests, target conditions, and populations.</p> <p>YES: if the test was dichotomous by nature, or if the threshold was stated in the methods section, or if authors stated that the threshold as recommended by the manufacturer was used.</p> <p>NO: if a receiver operating characteristic curve was drawn or multiple threshold reported in the results section; and the final result was based on one of these thresholds; if fever was not defined beforehand.</p> <p>UNCLEAR: if threshold selection was not clearly reported.</p>
Could the conduct or interpretation of the index test have introduced bias?	<p>HIGH: if one or more signalling questions were answered with NO, as even in a laboratory situation knowledge of the reference standard may lead to bias.</p> <p>LOW: if all signalling questions were answered with YES.</p> <p>UNCLEAR: all other instances.</p>
Is there concern that the index test, its conduct, or interpretation differ from the review question?	<p>This will probably be answered 'LOW' in all cases except when assessments were made in a different setting, or using personnel not available in practice.</p>
Reference standard	

Table 1. QUADAS-2 checklist (Continued)

Is the reference standard likely to correctly classify the target condition?	<p>We will define acceptable reference standards using a consensus process once the list of reference standards that have been used has been obtained from the eligible studies.</p> <p>For severe pneumonia, we will consider how well processes adhered to the WHO case definition in Appendix 1.</p>
Were the reference standard results interpreted without knowledge of the results of the index test?	<p>YES: if it was explicitly stated that the reference standard results were interpreted without knowledge of the results of the index test, or if the result of the index test was obtained after the reference standard.</p> <p>NO: if it was explicitly stated that the reference standard results were interpreted with knowledge of the results of the index test or if the index test was used to make the final diagnosis.</p> <p>UNCLEAR: if blinding was unclearly reported.</p>
Did the definition of the reference standard incorporate results from the index test(s)?	<p>YES: if results from the index test were a component of the reference standard definition.</p> <p>NO: if the reference standard did not incorporate the index standard test.</p> <p>UNCLEAR: if it was unclear whether the results of the index test formed part of the reference standard.</p>
Could the conduct or interpretation of the reference standard have introduced bias?	<p>HIGH: if one or more signalling questions were answered with NO.</p> <p>LOW: if all signalling questions were answered with YES.</p> <p>UNCLEAR: all other instances.</p>
Is there concern that the target condition as defined by the reference standard does not match the review question?	<p>HIGH: if the target condition was COVID-19 pneumonia, but only RT-PCR was used; if alternative diagnosis was highly likely and not excluded (will happen in paediatric cases, where exclusion of other respiratory pathogens is also necessary); if tests used to follow up viral load in known test-positives.</p> <p>LOW: if above situations were not present.</p> <p>UNCLEAR: if intention for testing was not reported in the study.</p>
Flow and timing	
Was there an appropriate interval between index test(s) and reference standard?	<p>YES: this will be similar for all index tests, populations for the current infection target conditions: as the situation of a patient, including clinical presentation and disease progress, evolves rapidly and new/ongoing exposure can result in case status change, an appropriate time interval will be within 24 hours.</p> <p>NO: if there was more than 24 hours between the index test and the reference standard or if participants were otherwise reported to be assessed with the index versus reference standard test at moments of different severity.</p> <p>UNCLEAR: if the time interval was not reported.</p>
Did all patients receive a reference standard?	<p>YES: if all participants received a reference standard (clearly no partial verification).</p> <p>NO: if only (part of) the index test-positives or index test-negatives received the complete reference standard.</p> <p>UNCLEAR: if it was not reported.</p>
Did all patients receive the same reference standard?	<p>YES: if all participants received the same reference standard (clearly no differential verification).</p> <p>NO: if (part of) the index test-positives or index test-negatives received a different reference standard.</p>

Table 1. QUADAS-2 checklist (Continued)

UNCLEAR: if it was not reported.

Were all patients included in the analysis?	<p>YES: if all included participants were included in the analyses.</p> <p>NO: if after the inclusion/exclusion process, participants were removed from the analyses for different reasons: no reference standard done, no index test done, intermediate results of both index test or reference standard, indeterminate results of both index test or reference standard, samples unusable.</p> <p>UNCLEAR: if this was not clear from the reported numbers.</p>
Could the patient flow have introduced bias?	<p>HIGH: if one or more signalling questions were answered with NO.</p> <p>LOW: if all signalling questions were answered with YES.</p> <p>UNCLEAR: all other instances.</p>

ICU: intensive care unit; **RT-PCR:** reverse transcription polymerase chain reaction; **SARS-CoV-2:** severe acute respiratory syndrome coronavirus 2; **WHO:** World Health Organization

Table 2. Summary of study characteristics

Study ID	Sample size	Prevalence	Setting	Population	Design	Reference standard
Ahmed 2020	2043	7%	Primarily outpatient settings	All patients tested for SARS-CoV-2 in the UHealth system	Single-gate (cross-sectional), retrospective	Not specified
Ai 2020	53	38%	Hospital in-patients	Patients hospitalised with pneumonia diagnosed by imaging	Single-gate (cross-sectional), prospective	PCR on nasopharyngeal swabs
Brotons 2020	634	39%	Primary care	Patients who had a face-to-face or phone consultation with their GP	Single-gate (cross-sectional), prospective	Positive serology for SARS-CoV-2 (IgM and/or IgG)
Carignan 2020	268	Not applicable	Hospital outpatients	Patients who underwent testing for SARS-CoV-2 at a hospital	Case-control	PCR, samples not specified
Challener 2020	146	Not applicable	Outpatients (drive-through specimen collection site)	Patients screened for SARS-CoV-2 (suspicion based on presenting symptoms)	Case-control	PCR, samples not specified
Cheng 2020	33	33%	Hospital outpatients	Patients presenting to a fever observation department	Single-gate (cross-sectional), retrospective	PCR on throat swab
Chen 2020	136	Not applicable	Hospital in-patients	Patients admitted with pneumonia	Case-control	PCR, samples not specified
Clemency 2020	961	23%	Outpatient settings	Healthcare workers triaged by phone, tested at drive-through site	Single-gate (cross-sectional), prospective	PCR on nasopharyngeal or

Signs and symptoms to determine if a patient presenting in primary care or hospital outpatient settings has COVID-19 (Review)

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Table 2. Summary of study characteristics (Continued)

						oropharyngeal swabs
Feng 2020	132	5%	Emergency department	Patients presenting to fever clinic of ED	Single-gate (cross-sectional), retrospective	PCR on throat swabs
Gilbert 2020	598	29%	Outpatient settings	Suspected patients sent to testing centres close to ED	Single-gate (cross-sectional), prospective	PCR on nasopharyngeal swabs
Haehner 2020	500	7%	Outpatient settings	Patients presenting with symptoms of a common cold to a COVID testing centre	Single-gate (cross-sectional), prospective	PCR on throat swabs
Huang 2020	475	71%	Hospital in-patients	Patients admitted into one of 26 COVID-19-designated hospitals	Single-gate (cross-sectional), retrospective	PCR, samples not specified
Just 2020	374	11%	Primary care	Convenience sample of patients who were tested in GP's practices	Single-gate (cross-sectional), prospective	PCR, samples not specified
Chua 2020	688	3%	Emergency department	Patients with acute respiratory symptoms, tested at ED	Single-gate (cross-sectional), retrospective	PCR on oropharyngeal swabs
Leal 2020	1583	28%	Outpatient settings	Patients meeting the suspected COVID-19 case definition (tested after initial screening questionnaire)	Single-gate (cross-sectional), prospective	PCR, samples not specified
Lee 2020	127	Not applicable	Outpatient settings	Patients tested at ambulatory assessment centre	Nested case-control	PCR on nasopharyngeal swabs
Liang 2020	88	24%	Hospital outpatients	Patients with pneumonia and presenting to fever clinic	Single-gate (cross-sectional), retrospective	PCR, sample not specified; conducted after panel discussion
Mao 2020	1004	19%	Hospital outpatients	Patients visiting the fever clinics (with fever or pulmonary symptoms)	Single-gate (cross-sectional), retrospective	PCR, sample not specified
Nobel 2020	516	Not applicable	Hospital outpatients	Patients who underwent SARS-CoV-2 testing seeking hospital treatment or in essential personnel	Case-control	PCR on nasopharyngeal swabs
O'Reilly 2020	240	5%	Emergency department	Patients who met the testing criteria for COVID-19 and who presented at the ED	Single-gate (cross-sectional), prospective	PCR, sample not specified
Peng 2020	86	13%	Hospital outpatients	Patients clinically suspected and referred for testing	Single-gate (cross-sectional), retrospective	PCR on nasopharyngeal swabs

Table 2. Summary of study characteristics (Continued)

Peyrony 2020	391	58%	Emergency department	Patients tested at ED, decision to test based on clinician's discretion	Single-gate (cross-sectional), prospective	PCR on nasal swabs
Pisapia 2020	37	46%	Emergency department/lab	Patients admitted in selected medical wards (ED + lab) of a mono-specialist infectious diseases referral centre because of clinical suspicion	Single-gate (cross-sectional), retrospective	PCR, different tests used (commercial kits used during study changed), negatives re-tested after 24 h, nasopharyngeal swab
Rentsch 2020	3789	15%	Unclear	Patients tested for SARS-CoV-2 in the Veterans Affairs Cohort born between 1945 and 1965	Single-gate (cross-sectional), retrospective	PCR on nasopharyngeal swabs
Salmon 2020	1824	47%	Outpatient setting	Patients suspected of SARS-CoV-2 infection, tested at screening centre	Single-gate (cross-sectional), prospective	PCR on nasopharyngeal swabs
Shah 2020	316	10%	Emergency department	Patients presenting at an ED with an acute respiratory illness	Single-gate (cross-sectional), retrospective	PCR test on oropharyngeal and/or nasopharyngeal swabs
Song 2020a	399	7%	Hospital outpatients	Patients tested for SARS-CoV-2	Single-gate (cross-sectional), retrospective	PCR on sputum samples
Sun 2020	788	Not applicable	Hospital outpatients	Patients presenting to testing centre, either self-referred, referred from primary care or at-risk cases identified by national contact tracing	Single-gate (cross-sectional), retrospective	PCR on sputum, endotracheal aspirate, nasopharyngeal swab or throat swab
Tolia 2020	283	10%	Emergency department	Patients presenting with symptoms, travel history, risk factors or healthcare workers	Single-gate (cross-sectional), retrospective	PCR on nasopharyngeal swabs
Tordjman 2020	100	Not applicable	Emergency department	Patients with both RT-PCR and CT-scan results available with a 1:1 patient:control inclusion ratio from ED	Single-gate (cross-sectional), retrospective	PCR (specimen not specified) or CT-scan lungs
Trubiano 2020	2935	4%	Outpatient setting	Patients presenting at a COVID-19 rapid assessment screening clinic, meeting DHHS screening criteria	Single-gate (cross-sectional), prospective	PCR on nasopharyngeal swabs
Tudrej 2020	816	24%	Primary care/ outpatient setting	Patients referred by GPs for PCR testing at lab	Single-gate (cross-sectional), prospective	PCR on nasopharyngeal swabs

Table 2. Summary of study characteristics (Continued)

Wee 2020	870	18%	Emergency Department	Patients presenting with respiratory symptoms or travel history	Single-gate (cross-sectional), prospective	PCR on oropharyngeal swabs
Wei 2020	936	67%	Hospital outpatient	Febrile patients visiting a fever clinic	Single-gate (cross-sectional), retrospective	PCR on throat-swab specimens
Xie 2020	105	20%	Hospital in-patients	Patients in whom PCR test was performed at two Shanghai hospitals	Single-gate (cross-sectional), retrospective	PCR testing on throat swab and sputum specimens, patients pre-selected on the presence of pneumonia (radiological findings)
Yan 2020	262	23%	Hospital outpatient	Patients presenting at hospital for SARS-CoV-2 testing, not otherwise specified	Other	PCR, samples not specified
Yang 2020	121	Not applicable	Hospital in-patients	Patient with pneumonia from SARS-CoV-2 and patients with pneumonia from influenza in 2015-2019	Case-control	PCR, samples not specified
Yombi 2020	536	33%	Unclear (health-care workers working at tertiary hospital)	Healthcare workers were tested if they had respiratory symptoms with or without fever	Single-gate (cross-sectional), unclear retro-or prospective	PCR, samples not specified
Zavascki 2020	464	21%	Hospital outpatients	Patients attending a screening clinic, suspicion based on fever or any respiratory symptom	Cross-sectional, retrospective	PCR, samples not specified
Zayet 2020a	124	56%	Hospital in-patients + outpatients	Patients with confirmed COVID-19 or confirmed influenza A/B who consulted or were hospitalised in the hospital	Case-control	PCR on nasopharyngeal swabs, sputum, bronchial aspirates or bronchoalveolar lavage fluids
Zayet 2020b	217	44%	Hospital outpatients	Patients presenting with possible COVID-19 at the outpatient department	Single-gate (cross-sectional), retrospective	PCR on nasopharyngeal swabs
Zhao 2020	34	Not applicable	Hospital in-patients	Patients with pneumonia and admitted to hospital	Case-control	PCR on throat or sputum swabs
Zhu 2020	116	28%	Emergency department	Patients suspected of SARS-CoV-2 and presenting to the ED	Single-gate (cross-sectional), retrospective	PCR, samples not specified

Table 2. Summary of study characteristics (Continued)

Zimmerman 2020	736	7%	Unclear	Not specified	Not specified	PCR, samples not specified
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CT: computed tomography; **DHHS:** Department of Health and Human Services; **ED:** emergency department; **GP:** general practitioner; **PCR:** polymerase chain reaction; **SARS-CoV-2:** severe acute respiratory syndrome coronavirus 2

Table 3. Study characteristics of papers investigating olfactory symptoms

Study	Recruitment	Prevalence of COVID-19	Setting + season	Measurement of symptoms
Brotons 2020	Mild or moderate symptoms without confirmed diagnosis (observational study)	634/742 underwent testing 244 were seropositive for IgM and/or IgG (38%)	Primary care Spring	Standardised questionnaire A team of trained GPs, nurses, and medical students carried out the survey
Carignan 2020	All patients who underwent testing for SARS-CoV-2 Adults who tested positive for SARS-CoV-2 were used to compare to control group	134/2883 (4.6%)	Hospital outpatients Winter-spring	All participants were interviewed via telephone by trained interviewers using a standardised questionnaire. Questions were adapted from the self-reported Mini Olfactory Questionnaire (validated questionnaire)
Clemency 2020	HCWs with symptoms concerning COVID-19	225 of 961 HCW (23%) tested positive	Outpatient settings Spring	HCW were evaluated for potential testing through a centralised nurse call centre. A standardised list of symptoms was developed and utilised as part of usual care by the health system's COVID-19 call centre.
Haehner 2020	Symptoms of a common cold + fulfilled COVID testing criteria	34 of 500 (6.8%) patients	Outpatient settings Spring	All patients who presented to the testing centre received a standardised questionnaire, which included the patients' main symptoms, time course and an additional self-assessment of the patients' current smell, taste function and nasal breathing compared to the level before onset of symptoms. The patients had indicate whether they experienced loss of smell and/or taste (yes vs no) and quantify this on a scale of 0-10 (0 = no function, 10 = best function)
Just 2020	Patients who received a PCR test Comparison of patients with positive and negative test results	40/347 tested positive for COVID-19 (12%)	Convenience sample of patients who were tested in GP's practices Spring	Data were collected based on a uniform quality standard in the documentation of COVID-19 suspect cases
Chua 2020	Acute respiratory symptoms	31/717 tested positive for COVID-19 (4.3%)	Emergency department Spring	Self-reported olfactory ability. ED started actively inquiring about olfactory loss in all patients who were included.

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Table 3. Study characteristics of papers investigating olfactory symptoms (Continued)

	Fulfilled suspect or surveillance case definition			
Leal 2020	Suspected COVID-19 symptoms	2073 suspected cases: 1583 were tested. 444 were positive. (28%) 604/1136 PCR-negative patients underwent serology. 52 tested positive. (8.6%)	Outpatient settings Autumn	Residents of the municipality of São Caetano do Sul aged ≥ 12 years with suspected COVID-19 symptoms were encouraged to contact a dedicated platform, where they were invited to complete a screening questionnaire that included socio-demographic data; information on symptoms type, onset and duration; and recent contacts.
Lee 2020	Adults who underwent PCR test (reason not specified)	102/1345 patients tested positive. (7.6%) 56/102 positive patients and 72 negative patients completed the survey	Outpatient settings Spring	Online survey. Baseline characteristics were collected and included. Smell and taste-specific questions included the presence of smell or taste loss around the onset of COVID-19 like symptoms, as well the current ability to smell.
O'Reilly 2020	Fulfilled testing criteria Cases not feasible to obtain a history in order to exclude COVID-19	240/1508 patients met inclusion criteria. 11 had a positive test result (4.6%)	Emergency department Autumn	Dedicated form embedded in the hospital's electronic medical record
Peyrony 2020	Symptomatic patients Patients with comorbidities that put them at risk of severe infection. No suspicion of COVID-19 but needing hospitalization	225/391 had positive test result for SARS-CoV-2 (58%)	Emergency department Winter-spring	Patient-reported symptoms, physical examination by emergency physicians
Salmon 2020	All consecutive patients who were tested for SARS-CoV-2 by RT-PCR during the same period	849 of 1824 (47%) tested positive	Outpatient setting Winter-spring	Patients were systematically assessed during the usual medical symptom's screening about their olfactory and gustatory dysfunction
Trubiano 2020	Patients that met DHHS criteria for SARS-CoV-2 testing	4226 patients, 2976 were tested (41 excluded) 108/2935 tested positive (3.8%)	Outpatient setting Autumn	Data systematically gathered of patients presenting to the clinic by medical staff
Tudrej 2020	Primary care patients with suspicion of COVID-19 based on symptoms	198/816 tested positive (24%)	Primary care/outpatient setting	Self-reported pre-formatted questionnaire about their symptoms

Table 3. Study characteristics of papers investigating olfactory symptoms (Continued)

			Spring	
Wee 2020	New-onset olfactory or taste disorders Suspected COVID-19 case	155 of 870 (18%) patients tested positive	Emergency department Spring	Self-reported, a questionnaire including respiratory symptoms, self-reported OTD, and travel and epidemiological risk factors was administered at ED triage to risk-stratify admissions
Zayet 2020a	Adult patients with confirmed COVID-19 or confirmed influenza A/B	124 patients 70 COVID + (56%) 54 Influenza A/B +	Hospital inpatients + outpatients Winter	Standardised questionnaire for each patient with suspected COVID-19 (also suspected influenza) to help screen their functional symptoms and the onset and duration of their symptoms.
Zayet 2020b	Possible COVID-19 based on symptoms	95/217 had a positive PCR (44%) 122 had a negative PCR	Hospital outpatients Spring	Standardised questionnaire was designed to specify the symptoms in patients consulting for COVID-19 suspicion.
Zimmerman 2020	Suspected cases of COVID-19 based on symptoms	55/736 tested positive (7.4%)	Unclear Spring	Symptoms reported at enrolment

ED: emergency department; **GP:** general practitioner; **HCW:** healthcare workers; **OTD:** olfactory and taste disorder; **PCR:** polymerase chain reaction; **SARS-CoV-2:** severe acute respiratory syndrome coronavirus 2

Table 4. Summary point statistics of selected index tests, including 95% confidence intervals (bivariate meta-analysis, analyses restricted to cross-sectional studies)

Index test	Number of studies	Number of COV-ID-19 positives/ Total number of participants n/N (%)	Sensitivity (95% CI)	Specificity (95% CI)	LR+ (95% CI)	LR- (95% CI)	DOR (95% CI)
A. All cross-sectional studies							
Cough	25	3207/15,459 (20.7%)	67.4% (59.8% to 74.1%)	35.0% (28.7% to 41.9%)	1.036 (0.969 to 1.107)	0.933 (0.816 to 1.067)	1.110 (0.909 to 1.356)
Anosmia	11	2305/9552 (24.1%)	28.0% (17.7% to 41.3%)	93.4% (88.3% to 96.4%)	4.254 (3.172 to 5.705)	0.771 (0.676 to 0.879)	5.549 (4.089 to 7.532)
Ageusia	6	1893/7393 (25.6%)	24.8% (12.4% to 43.5%)	91.4% (81.3% to 96.3%)	2.876 (2.021 to 4.092)	0.823 (0.712 to 0.951)	3.495 (2.408 to 5.072)
Anosmia or ageusia	6	1589/8142 (19.5%)	41.0% (27.0% to 56.6%)	90.5% (81.2% to 95.4%)	4.306 (3.002 to 6.177)	0.652 (0.542 to 0.785)	6.602 (5.271 to 8.270)
Sore throat	20	3308/15,876 (20.8%)	21.2% (13.5% to 31.6%)	69.5% (58.1% to 78.9%)	0.694 (0.565 to 0.853)	1.134 (1.053 to 1.222)	0.612 (0.473 to 0.793)
Myalgia	13	2033/8105 (25.1%)	26.6% (15.3% to 42.2%)	83.1% (70.6% to 90.9%)	1.575 (1.260 to 1.968)	0.883 (0.810 to 0.962)	1.783 (1.367 to 2.327)
Fatigue	12	1727/5553 (31.1%)	36.4% (22.1% to 53.6%)	74.7% (63.6% to 83.3%)	1.438 (1.142 to 1.811)	0.851 (0.727 to 0.997)	1.689 (1.166 to 2.247)
Dyspnoea	24	2878/14,913 (19.3%)	24.9% (16.6% to 35.5%)	77.1% (66.8% to 84.8%)	1.084 (0.906 to 1.299)	0.975 (0.921 to 1.032)	1.112 (0.878 to 1.409)
Diarrhoea	20	2342/13,016 (18.0%)	11.6% (5.0% to 26.5%)	90.6% (83.3% to 95.8%)	1.232 (0.978 to 1.554)	0.976 (0.888 to 1.069)	1.263 (0.978 to 1.640)

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Table 4. Summary point statistics of selected index tests, including 95% confidence intervals (bivariate meta-analysis, analyses restricted to cross-sectional studies) (Continued)

Anosmia or ageusia	6	1589/8142 (19.5%)	41.0%	90.5%	(86.6% to 93.5%)	(1.006 to 1.509)	(0.948 to 1.004)	(1.004 to 1.588)
Sputum production	10	1426/5144 (27.7%)	18.9%	81.3%	(57.9% to 93.2%)	(0.680 to 1.497)	(0.912 to 1.092)	(0.622 to 1.642)
Nausea or vomiting	8	1059/5381 (19.7%)	5.4%	95.3%	(92.0% to 97.3%)	(0.676 to 1.942)	(0.963 to 1.024)	(0.660 to 2.017)
Chest tightness	6	1518/6057 (25.1%)	4.7%	94.6%	(88.6% to 97.6%)	(0.568 to 1.349)	(0.982 to 1.033)	(0.550 to 1.373)
B. Sensitivity analysis: cross-sectional studies with a prospective data-collection only								
Fever	7	860/5548 (15.5%)	53.8%	67.4%	(53.3% to 78.9%)	(1.413 to 1.930)	(0.534 to 0.879)	(1.745 to 3.331)
Cough	7	1484/6411 (23.1%)	66.3%	40.7%	(33.6% to 48.3%)	(1.005 to 1.243)	(0.686 to 1.001)	(1.008 to 1.805)
Headache	6	1473/6171 (23.9%)	21.9%	80.1%	(60.2% to 91.4%)	(0.872 to 1.379)	(0.914 to 1.043)	(0.839 to 1.504)
Dyspnoea	6	840/5495 (15.3%)	37.0%	66.0%	(56.3% to 74.6%)	(0.852 to 1.391)	(0.821 to 1.110)	(0.768 to 1.693)
Sore throat	6	1464/6928 (21.1%)	32.2%	57.9%	(43.9% to 70.8%)	(0.690 to 0.849)	(1.052 to 1.302)	(0.540 to 0.793)
Diarrhoea	6	635/5157 (12.3%)	23.8%	85.1%	(77.2% to 90.6%)	(0.903 to 2.826)	(0.767 to 1.046)	(0.869 to 3.660)
Myalgia	4	488/1926 (25.3%)	NA	NA	NA	NA	NA	NA

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Table 4. Summary point statistics of selected index tests, including 95% confidence intervals (bivariate meta-analysis, analyses restricted to cross-sectional studies) *(Continued)*

Fatigue	6	752/2613 (28.8%)	35.7% (17.2% to 59.7%)	74.0% (56.1% to 86.4%)	1.373 (0.901 to 2.094)	0.869 (0.688 to 1.098)	1.581 (0.837 to 2.984)
Sputum production	1	225/961 (23.4%)	NA	NA	NA	NA	NA
Nausea or vomiting	2	264/687 (38.4%)	NA	NA	NA	NA	NA
Chest tightness	2	333/3326 (10.0%)	NA	NA	NA	NA	NA
Anosmia	8	2129/8518 (25.0%)	29.1% (18.9% to 42.1%)	92.3% (85.8% to 95.9%)	3.765 (2.783 to 5.092)	0.768 (0.682 to 0.866)	4.900 (3.717 to 6.460)
Ageusia	5	1843/7293 (25.3%)	29.4% (15.1% to 49.5%)	89.0% (77.6% to 94.9%)	2.667 (1.957 to 3.636)	0.793 (0.669 to 0.941)	3.362 (2.382 to 4.746)
Anosmia or ageusia	5	1534/7406 (20.7%)	36.5% (24.0% to 51.2%)	92.4% (84.1% to 96.5%)	4.782 (3.182 to 7.185)	0.687 (0.586 to 0.806)	6.955 (5.195 to 9.312)
CI: confidence interval; DOR: diagnostic odds ratio; LR+: positive likelihood ratio; LR-: negative likelihood ratio; NA: not applicable, number of studies too small to perform meta-analysis							

APPENDICES

Appendix 1. World Health Organization case definitions

Severe pneumonia

Adolescent or adult: fever or suspected respiratory infection, plus one of the following: respiratory rate higher than 30 breaths/minute; severe respiratory distress; or oxygen saturation (SpO_2) 93% or less on room air. Child with cough or difficulty in breathing, plus at least one of the following: central cyanosis or SpO_2 less than 90%; severe respiratory distress (for example, grunting, very severe chest indrawing); signs of pneumonia with a general danger sign: inability to breastfeed or drink, lethargy or unconsciousness, or convulsions.

Other signs of pneumonia may be present: chest indrawing, fast breathing (in breaths/minute): aged under 2 months: 60 or higher; aged 2 to 11 months: 50 or higher; aged 1 to 5 years: 40 or higher. While the diagnosis is made on clinical grounds; chest imaging may identify or exclude some pulmonary complications.

Acute respiratory distress syndrome (ARDS)

Onset within one week of a known clinical insult or new or worsening respiratory symptoms.

Chest imaging (that is, X-ray, computed tomography (CT) scan, or lung ultrasound): bilateral opacities, not fully explained by volume overload, lobar or lung collapse, or nodules.

Origin of pulmonary infiltrates: respiratory failure not fully explained by cardiac failure or fluid overload. Need objective assessment (for example, echocardiography) to exclude hydrostatic cause of infiltrates/oedema if no risk factor present.

Oxygenation impairment in adults:

- mild ARDS: 200 mmHg less than ratio of arterial oxygen partial pressure/fractional inspired oxygen ($\text{PaO}_2/\text{FiO}_2$) 300 mmHg or less (with positive end-expiratory pressure (PEEP) or continuous positive airway pressure (CPAP) 5 cmH_2O , or more, or non-ventilated);
- moderate ARDS: $100 \text{ mmHg} < \text{PaO}_2/\text{FiO}_2 \leq 200 \text{ mmHg}$ (with $\text{PEEP} \geq 5 \text{ cmH}_2\text{O}$, or non-ventilated);
- severe ARDS: $\text{PaO}_2/\text{FiO}_2 \leq 100 \text{ mmHg}$ (with $\text{PEEP} \geq 5 \text{ cmH}_2\text{O}$, or non-ventilated);
- when PaO_2 is not available, $\text{SpO}_2/\text{FiO}_2 \leq 315 \text{ mmHg}$ suggests ARDS (including in non-ventilated patients).

Oxygenation impairment in children: note OI = Oxygenation Index and OSI = Oxygenation Index using SpO_2 . Use PaO_2 -based metric when available. If PaO_2 not available, wean FiO_2 to maintain $\text{SpO}_2 \leq 97\%$ to calculate OSI or $\text{SpO}_2/\text{FiO}_2$ ratio:

- bilevel (non-invasive ventilation or CPAP) $\geq 5 \text{ cmH}_2\text{O}$ via full-face mask: $\text{PaO}_2/\text{FiO}_2 \leq 300 \text{ mmHg}$ or $\text{SpO}_2/\text{FiO}_2 \leq 264$;
- mild ARDS (invasively ventilated): $4 \leq \text{OI} < 8$ or $5 \leq \text{OSI} < 7.5$;
- moderate ARDS (invasively ventilated): $8 \leq \text{OI} < 16$ or $7.5 \leq \text{OSI} < 12.3$;
- severe ARDS (invasively ventilated): $\text{OI} \geq 16$ or $\text{OSI} \geq 12.3$.

Appendix 2. Search classification model

We needed a more efficient approach to keep up with the rapidly increasing volume of COVID-19 literature. A classification model for COVID-19 diagnostic studies was built with the model building function within Eppi Reviewer, which uses the standard SGCClassifier in Scikit-learn on word trigrams. As outputs, new documents receive a percentage (from the predict_proba function) where scores close to 100 indicate a high probability of belonging to the class 'relevant document' and scores close to 0 indicate a low probability of belonging to the class 'relevant document'. We used three iterations of manual screening (title and abstract screening, followed by full-text review) to build and test classifiers. The final included studies were used as relevant documents, while the remainder of the COVID-19 studies were used as irrelevant documents. The classifier was trained on the first round of selected articles, and tested and retrained on the second round of selected articles. Testing on the second round of selected articles revealed poor positive predictive value but 100% sensitivity at a cut-off of 10. The poor positive predictive value is mainly due to the broad scope of our topic (all diagnostic studies in COVID-19), poor reporting in abstracts, and a small set of included documents. The model was retrained using the articles selected of the second and third rounds of screening, which added a considerable number of additional documents. This led to a large increase in positive predictive value, at the cost of a lower sensitivity, which led us to reduce the cut-off to 5. The largest proportion of documents had a score between 0-5. This set did not contain any of the relevant documents. This version of the classifier with a cut-off 5 was used in subsequent rounds and accounted for approximately 80% of the screening burden.

Appendix 3. Cochrane COVID-19 Study Register searches

Source	Strategy
ClinicalTrials.gov	COVID-19 OR 2019-nCoV OR SARS-CoV-2 OR 2019 novel coronavirus OR severe acute respiratory syndrome coronavirus 2 OR Wuhan coronavirus
WHO ICTRP	We screened the entire COVID-19.csv file available from https://www.who.int/emergencies/diseases/novel-coronavirus-2019
PubMed	("2019 nCoV"[tiab] OR 2019nCoV[tiab] OR "2019 novel coronavirus"[tiab] OR ((coronavirus[tiab] OR "corona virus"[tiab]) AND (Huanan[tiab] OR Hubei[tiab] OR Wuhan[tiab])) OR "coronavirus-19"[tiab] OR "coronavirus disease-19"[tiab] OR "coronavirus disease-2019"[tiab] OR "COVID 19"[tiab] OR COVID19[tiab] OR "nCov 2019"[tiab] OR "new coronavirus"[tiab] OR "new coronaviruses"[tiab] OR "novel coronavirus"[tiab] OR "novel coronaviruses"[tiab] OR "novel corona virus"[tiab] OR "SARS-CoV2"[tiab] OR "SARS CoV-2"[tiab] OR SARSCoV2[tiab] OR "SARSCoV-2"[tiab] OR "SARS-coronavirus-2"[tiab] OR "SARS-like coronavirus"[tiab] OR "Severe Acute Respiratory Syndrome Coronavirus-2"[tiab] OR "COVID-19"[nm] OR "COVID-19 drug treatment"[nm] OR "COVID-19 diagnostic testing"[nm] OR "COVID-19 serotherapy"[nm] OR "COVID-19 vaccine"[nm] OR "LAMP assay"[nm] OR "severe acute respiratory syndrome coronavirus 2"[nm] OR "spike protein, SARS-CoV-2"[nm]) NOT ("animals"[mh] NOT "humans"[mh]) NOT (editorial[pt] OR newspaper article[pt])

Appendix 4. Living search from the University of Bern

We took the following information from the university of Bern website (see: ispmbern.github.io/covid-19/living-review/collectingdata.html).

The register is updated daily and CSV file downloads are made available.

1 April 2020

From 1 April 2020, we will retrieve the curated BioRxiv/MedRxiv dataset (connect.medrxiv.org/relate/content/181).

26 to 31 March 2020

MEDLINE: ("Wuhan coronavirus" [Supplementary Concept] OR "COVID-19" OR "2019 nCoV"[tiab] OR ("novel coronavirus"[tiab] OR "new coronavirus"[tiab]) AND (wuhan[tiab] OR 2019[tiab])) OR 2019-nCoV[All Fields] OR (wuhan[tiab] AND coronavirus[tiab]))

Embase: (nCoV or 2019-nCoV or ((new or novel or wuhan) adj3 coronavirus) or covid19 or covid-19 or SARS-CoV-2).mp.

BioRxiv/MedRxiv: nCoV or corona or wuhan or COVID or SARS-CoV-2

With the kind support of the Public Health & Primary Care Library PHC (www.unibe.ch/university/services/university_library/faculty_libraries/medicine/public_health_amp_primary_care_library_phc/index_eng.html), and following guidance of the Medical Library Association (www.mlanet.org/p/cm/ld/fid=1713).

1 January 2020 to 25 March 2020

MEDLINE: ("Wuhan coronavirus" [Supplementary Concept] OR "COVID-19" OR "2019 nCoV"[tiab] OR ("novel coronavirus"[tiab] OR "new coronavirus"[tiab]) AND (wuhan[tiab] OR 2019[tiab])) OR 2019-nCoV[All Fields] OR (wuhan[tiab] AND coronavirus[tiab]))

Embase: nCoV OR (wuhan AND corona) OR COVID

BioRxiv/MedRxiv: nCoV or corona or wuhan or COVID

Appendix 5. CDC Library, COVID-19 Research Articles Downloadable Database

Embase records from the Stephen B. Thacker CDC Library, COVID-19 Research Articles Downloadable Database.

Records were obtained by the CDC library by searching Embase through Ovid using the following search strategy.

Source	Strategy
Embase	<p>(coronavir* OR corona virus* OR betacoronavir* OR covid19 OR covid 19 OR nCoV OR novel CoV OR CoV 2 OR CoV2 OR sarscov2 OR 2019nCoV OR wuhan virus*).mp. OR ((wuhan OR hubei OR huanan) AND (severe acute respiratory OR pneumonia*) AND outbreak*).mp. OR Coronavirus infection/ OR coronavirinae/ OR exp betacoronavirus/</p> <p>Limits: 2020-</p> <p>OR</p> <p>(novel coronavir* OR novel corona virus* OR covid19 OR covid 19 OR nCoV OR novel CoV OR CoV 2 OR CoV2 OR sarscov2 OR 2019nCoV OR wuhan virus*).mp. OR ((wuhan OR hubei OR huanan) AND (severe acute respiratory OR pneumonia*) AND outbreak*).mp. OR ((wuhan OR hubei OR huanan) AND (coronavir* OR betacoronavir*)).mp.</p> <p>Limits: 2019-</p>

WHAT'S NEW

Date	Event	Description
4 March 2021	Amended	Corrected peer reviewer's name in Acknowledgements section

HISTORY

Review first published: Issue 7, 2020

Date	Event	Description
11 February 2021	New citation required and conclusions have changed	Review updated: We retrieved 28 more studies on signs and symptoms in suspected COVID-19 patients, allowing pooling of the data for some features and estimation of summary measures of diagnostic accuracy. Moreover, this update contains new studies on the diagnostic value of olfactory symptoms, and includes a limited number of studies on combinations of symptoms.
8 December 2020	New search has been performed	Review updated
7 July 2020	Amended	Resolution of two figures improved

CONTRIBUTIONS OF AUTHORS

JD, JDi, YT, CD, ML, RS, LH, AVdB, and DE, contributed clinical, methodological and/or technical expertise to drafting the protocol. JD coordinated contributions from all co-authors and drafted the protocol. ML drafted the QUADAS-2 criteria. AVdB oversaw the overall progress of this review, participated in the selection process, data extraction and drafting of the manuscript. TS analyzed the data, drafted the manuscript and participated in the selection and data extraction. JD and BH participated in the data extraction, interpretation of the findings and commented on the manuscript.

DECLARATIONS OF INTEREST

Thomas Struyf: none known

Signs and symptoms to determine if a patient presenting in primary care or hospital outpatient settings has COVID-19 (Review)

201

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Jonathan J Deeks: none known

Jacqueline Dinnes: none known

Yemisi Takwoingi: none known

Clare Davenport: none known

Mariska MG Leeflang: none known

René Spijker: the Dutch Cochrane Centre (DCC) has received grants for performing commissioned systematic reviews. In no situation did the commissioner have any influence on the results of the work.

Lotty Hooft: none known

Devy Emperador: is employed by FIND. FIND is a global non-for profit product development partnership and WHO Diagnostic Collaboration Centre. It is FIND's role to accelerate access to high quality diagnostic tools for low resource settings and this is achieved by supporting both R&D and access activities for a wide range of diseases, including COVID-19. FIND has several clinical research projects to evaluate multiple new diagnostic tests against published Target Product Profiles that have been defined through consensus processes. These studies are for diagnostic products developed by private sector companies who provide access to know-how, equipment/reagents, and contribute through unrestricted donations as per FIND policy and external SAC review.

Julie Domen: none known

Sebastiaan Horn: none known

Ann Van den Bruel: none known

SOURCES OF SUPPORT

Internal sources

- Liverpool School of Tropical Medicine, UK
- University of Birmingham, UK

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- Department for International Development, UK

Project number: 300342-104

- National Institute for Health Research (NIHR), UK
- NIHR Birmingham Biomedical Research Centre at the University Hospitals Birmingham NHS Foundation Trust and the University of Birmingham, UK

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

- Clarification regarding inclusion criteria: suspicion of infection was interpreted as: **clinical** suspicion of SARS-CoV-2 infection **based on a symptomatic presentation. At least 50% of the study population had to present with COVID-19 compatible symptoms.**
- We performed sensitivity analyses to investigate the impact of prospective versus retrospective data collection in cross-sectional studies.

INDEX TERMS

Medical Subject Headings (MeSH)

Ageusia [diagnosis] [etiology]; *Ambulatory Care; Anosmia [diagnosis] [etiology]; Arthralgia [diagnosis] [etiology]; Bias; Cough [diagnosis] [etiology]; COVID-19 [complications] [*diagnosis] [epidemiology]; Diarrhea [diagnosis] [etiology]; Dyspnea [diagnosis] [etiology]; Fatigue [diagnosis] [etiology]; Fever [diagnosis] [etiology]; Headache [diagnosis] [etiology]; Myalgia [diagnosis] [etiology]; Outpatient Clinics, Hospital [statistics & numerical data]; Pandemics; Physical Examination; *Primary Health Care; *SARS-CoV-2; Selection Bias; *Symptom Assessment [classification] [statistics & numerical data]

MeSH check words

Humans

The Detroit News

MICHIGAN

Spectrum Health workers can use natural immunity as vaccine mandate exemption

Beth LeBlanc The Detroit News

Published 5:40 p.m. ET Sept. 9, 2021 | Updated 3:03 p.m. ET Sept. 12, 2021

Spectrum Health will grant temporary exemptions from its employee vaccine mandate to individuals who can prove they have naturally acquired immunity to COVID-19.

The west Michigan hospital system, which is in the process of merging with Southfield-based Beaumont Health, will grant an exemption to those who have a positive PCR or antigen test for COVID-19 plus a positive antibody test from within the past three months, the health system said in a statement Thursday.

The exemption, the first for a major health system in Michigan, was developed "as new research has emerged" on natural immunity.

"While we still recommend vaccination for people with prior COVID-19 infection, according to this new research, there is increasing evidence that natural infection affords protection from COVID-19 reinfection and severe symptoms for a period of time," the statement said. "Current studies are not clear on how long natural immunity protects from reinfection."

The policy could be updated if future evidence shows naturally acquired protection is waning or longer lasting, or if there is a validated antibody test result showing immunity, the statement said.

Spectrum announced in late July that it would require the COVID-19 vaccine within eight weeks of the Food and Drug Administration approving a vaccine, but noted it would consider some exemptions.

Those exemptions include religious exemptions and medical exemptions determined by a medical exemption committee. The hospital system's medical exemption committee recommended the health system allow for a temporary exemption for naturally acquired immunity based on available research, the statement said.

Detroit-based Henry Ford Health System, Beaumont Health and Trinity Heath Michigan have required their employees to get the vaccine with no exemptions for naturally acquired immunity.

Spectrum and Beaumont signed a formal integration agreement last week moving the process forward. The two health systems hope to launch a new system this fall.

It's not clear what influence, if any, Spectrum's policy will have on Beaumont workers who are not granted the same natural immunity exemption.

"We can't speculate on what will happen in the future," said Bob Ortlieb, a spokesman for Beaumont.

The U.S. Centers for Disease Control and Prevention has said current evidence suggests it is uncommon for people who have COVID-19 to become reinfected within 90 days.

"Experts don't know for sure how long this protection lasts, and the risk of severe illness and death from COVID-19 far outweighs any benefits of natural immunity," the CDC said.

The CDC in August said previously infected individuals in a Kentucky study who declined vaccination were more than twice as likely to be reinfected than the fully vaccinated.

A separate Cleveland Clinic study found employees who had tested positive for the virus and declined vaccination were not reinfected during a five-month period.

eleblanc@detroitnews.com

State COVID-19 Data and Policy Actions

Published: Nov 11, 2021



DASHBOARDS

Explore state-level data on a variety of COVID-19 metrics, including the latest hotspots and hospitalizations; cases, deaths, and vaccinations by race and ethnicity; and cases and deaths at long-term care facilities. Find up-to-date information on state policy actions on social distancing measures and reducing barriers to COVID-19 testing and treatment.

Jump to:

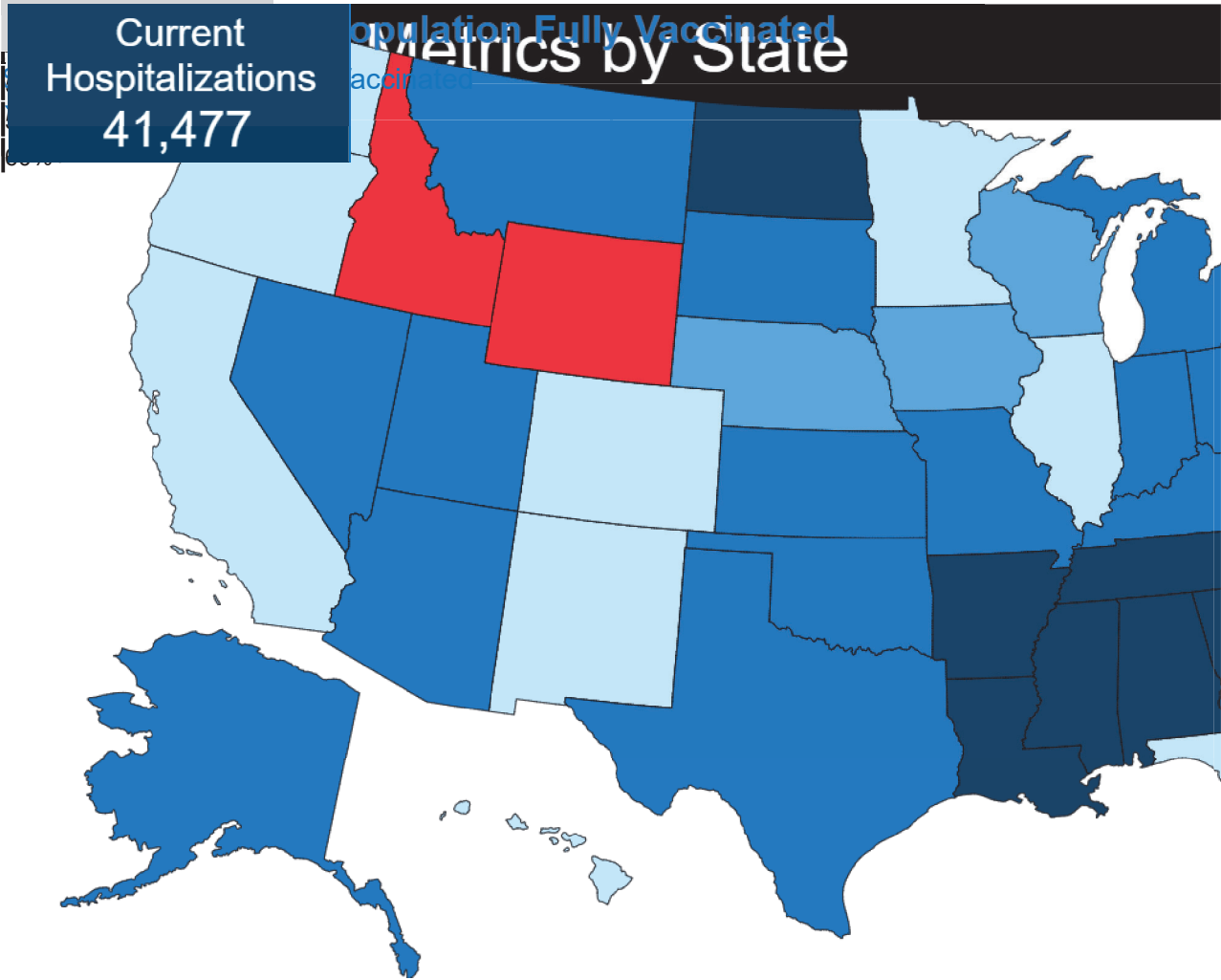
[Metrics by State](#) | [Metrics by Race/Ethnicity](#) | [Metrics in Long-term Care Facilities](#)

Explore State COVID-19 Policy Actions:

[Social Distancing Actions](https://www.kff.org/report-section/state-covid-19-data-and-policy-actions-policy-actions/#socialdistancing)(<https://www.kff.org/report-section/state-covid-19-data-and-policy-actions-policy-actions/#socialdistancing>) | [State COVID-19 Health Policy Actions](https://www.kff.org/report-section/state-covid-19-data-and-policy-actions-policy-actions/#policyactions)(<https://www.kff.org/report-section/state-covid-19-data-and-policy-actions-policy-actions/#policyactions>) | [Vaccines](https://www.kff.org/report-section/state-covid-19-data-and-policy-actions-policy-actions/#vaccines)
(<https://www.kff.org/report-section/state-covid-19-data-and-policy-actions-policy-actions/#vaccines>)
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Metrics by State

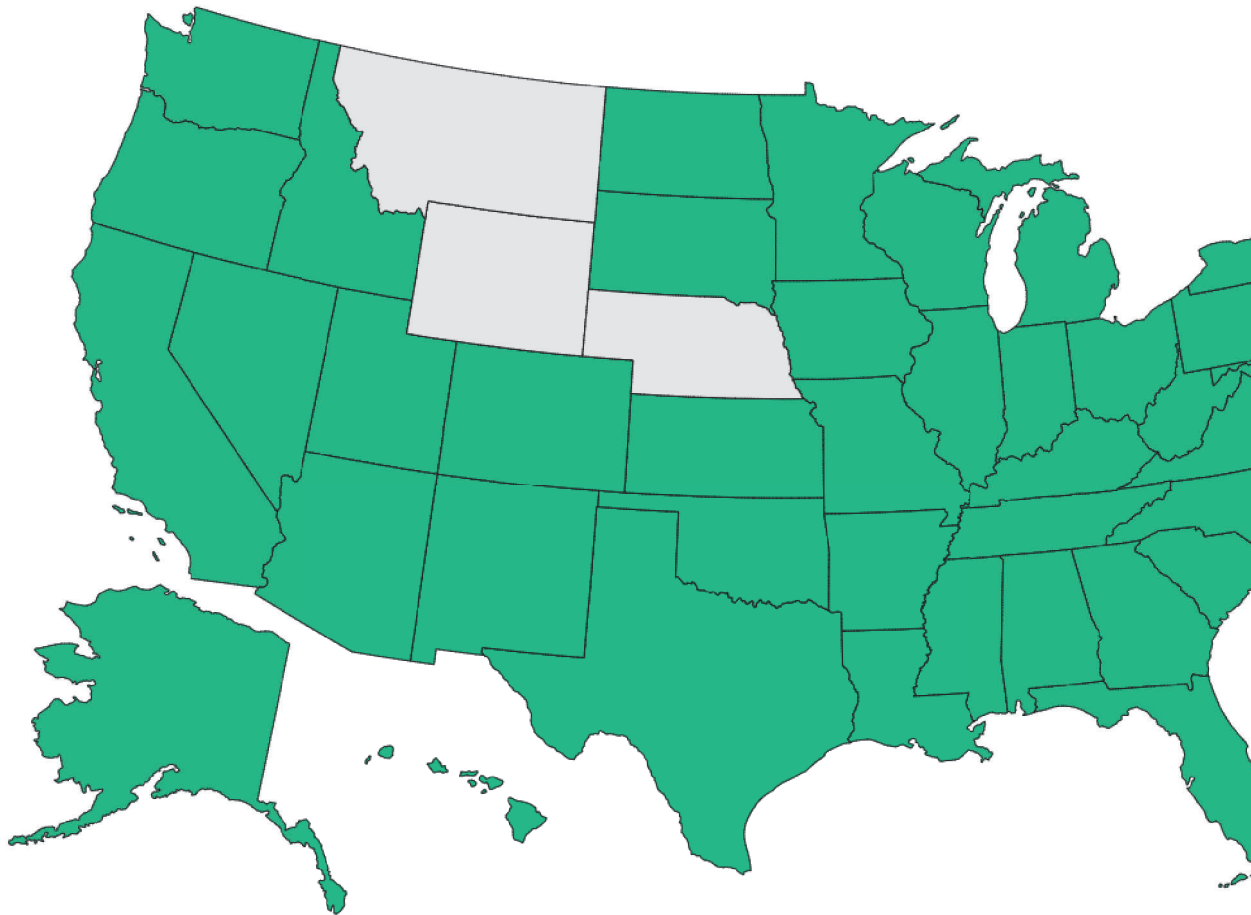
Vaccines



(
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Metrics by Race/Ethnicity

9: Vaccinations by Race/Ethnic



Metrics in Long-term Care Facilities

Sources/Notes

Select Metrics

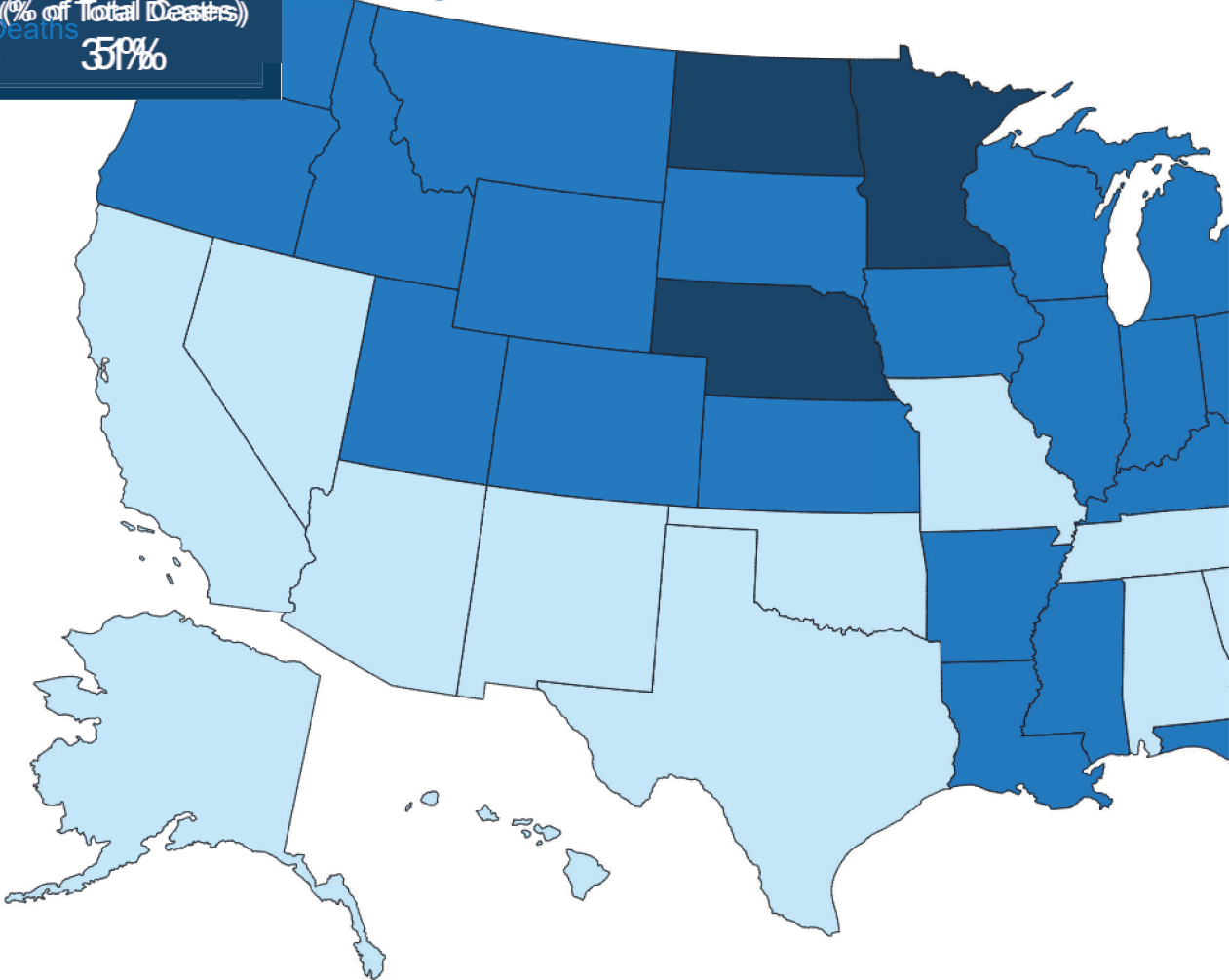
LTC Deaths

(% of Total Deaths)

Deaths

39%

LTC Facility Deaths as a Share of Total State Deaths



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State of the Long Term Care Industry:

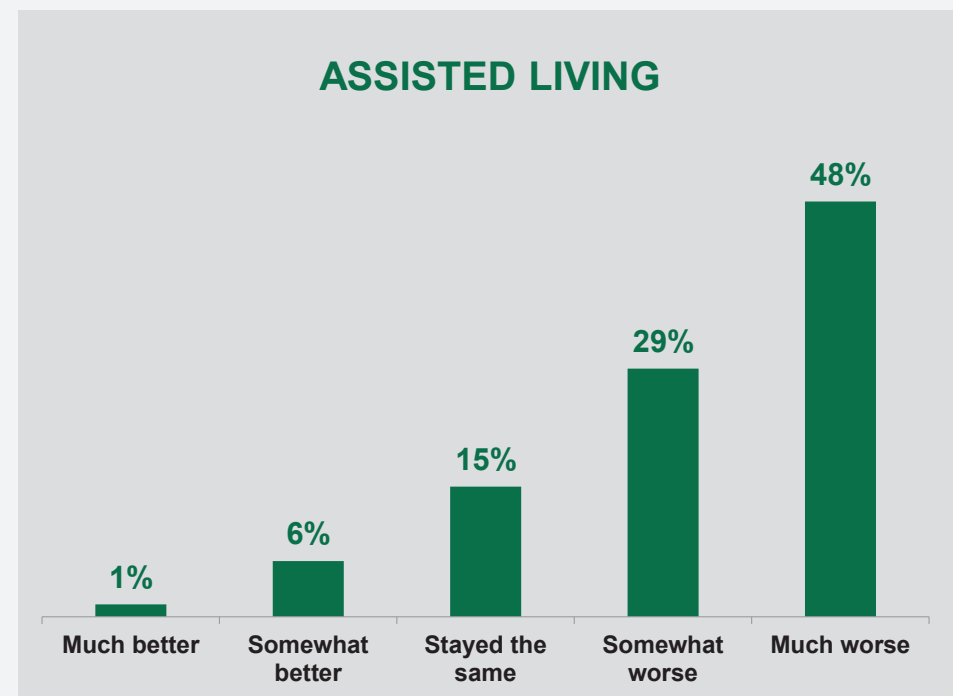
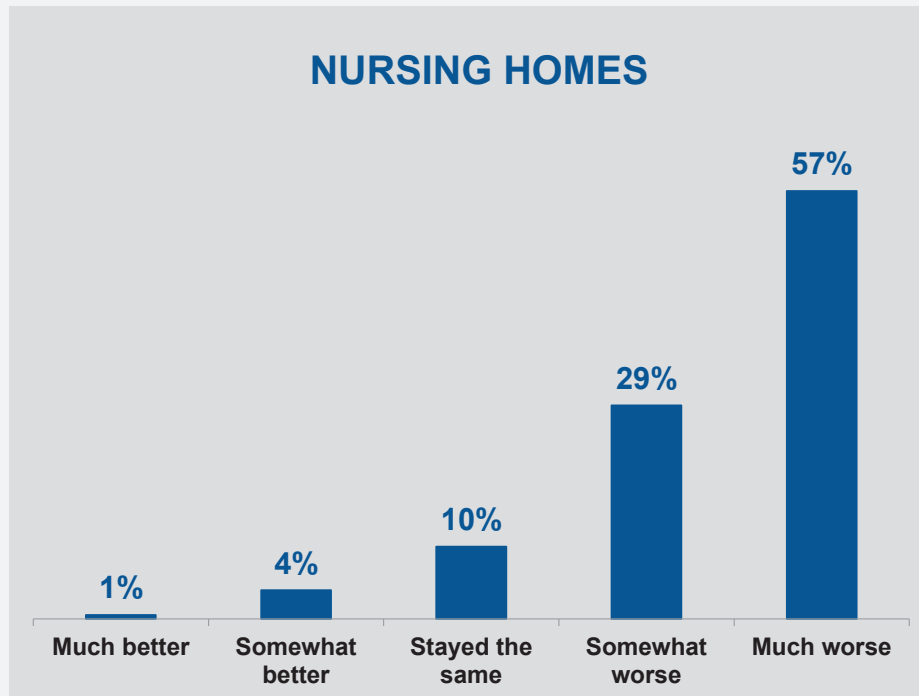
Survey of nursing home and assisted living providers show industry
facing significant workforce crisis

September 2021



86% of nursing homes and 77% of assisted living providers said their workforce situation has gotten worse over the last three months.

Q: Since June 2021, would you say your organization's overall workforce situation has generally gotten better or worse?

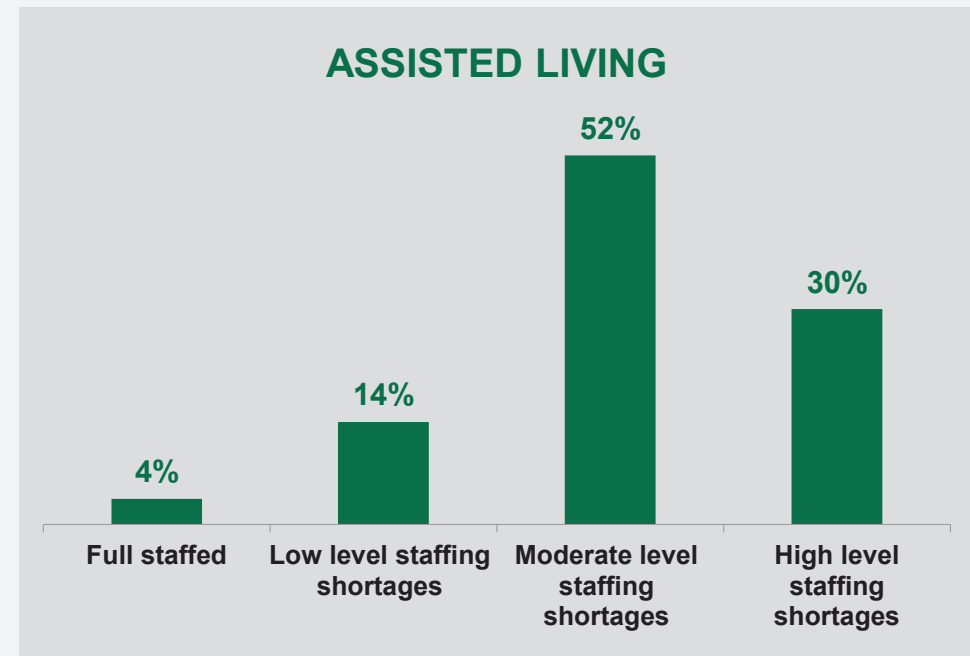
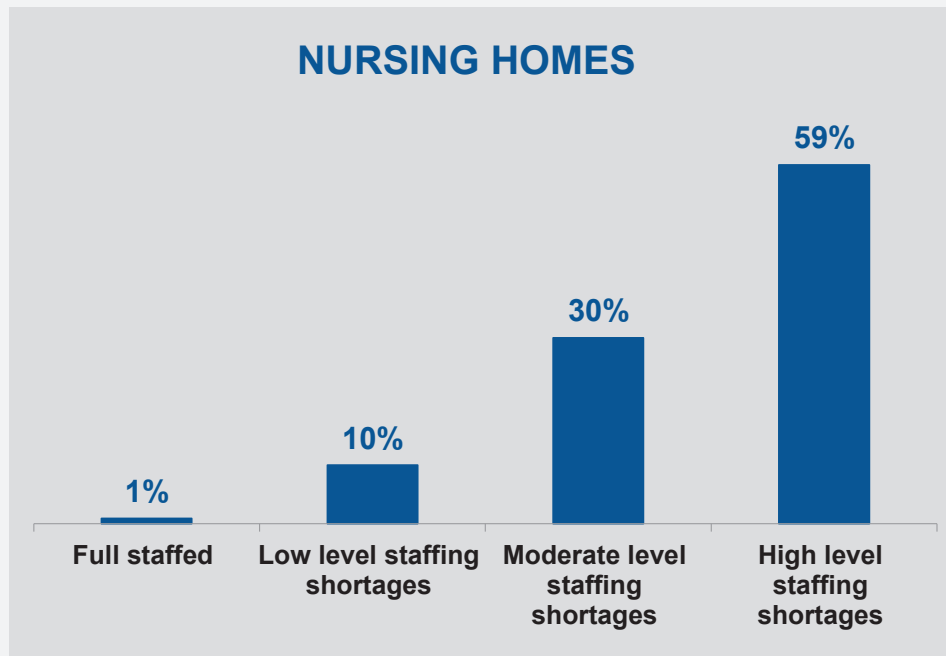


Source: American Health Care Association & National Center for Assisted Living Survey of 1,183 Nursing Home and Assisted Living Providers, September 2021



**Nearly every nursing home (99%) and assisted living community (96%)
in the U.S. is facing a staffing shortage.**

Q: What is your current staffing situation?

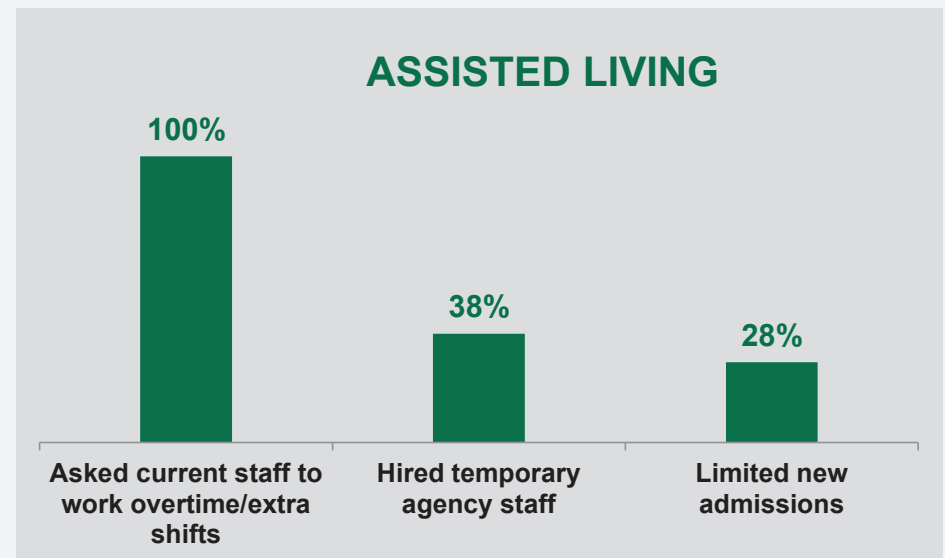
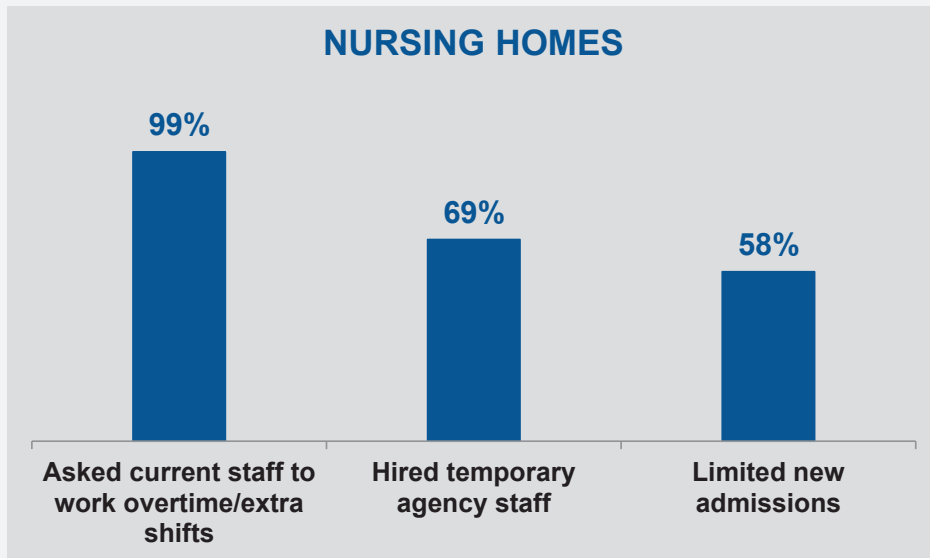


Source: American Health Care Association & National Center for Assisted Living Survey of 1,183 Nursing Home and Assisted Living Providers, September 2021



Nearly every nursing home and assisted living community is asking staff to work overtime or extra shifts.
58% of nursing homes are limiting new admissions due to staffing shortages.

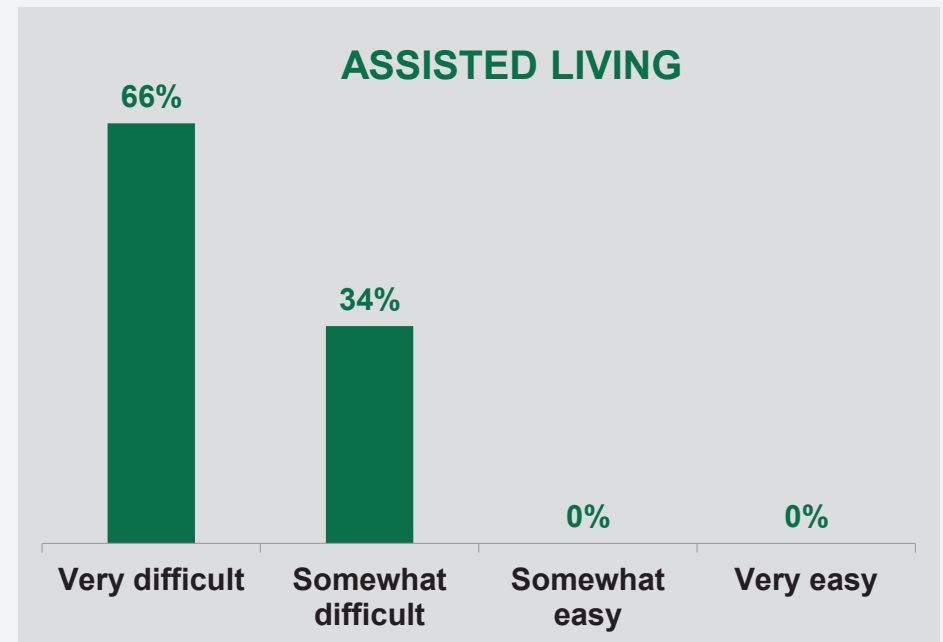
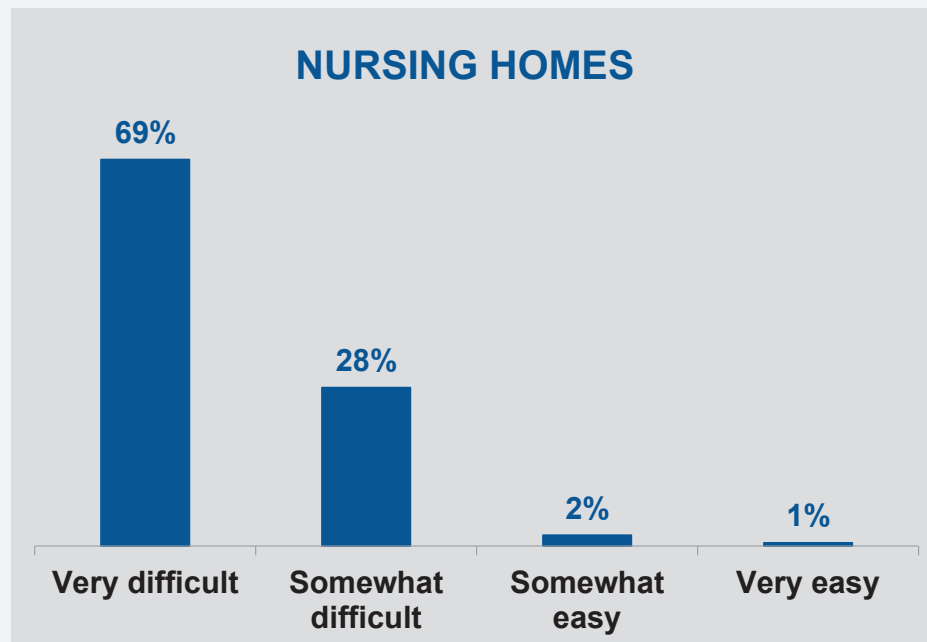
Q. What adjustments have you made due to staffing shortages?





Nearly every nursing home and assisted living provider is having a difficult time hiring new staff with nearly 7 out of 10 saying they are having a very difficult time.

Q. How would you rate your ability to hire new staff?

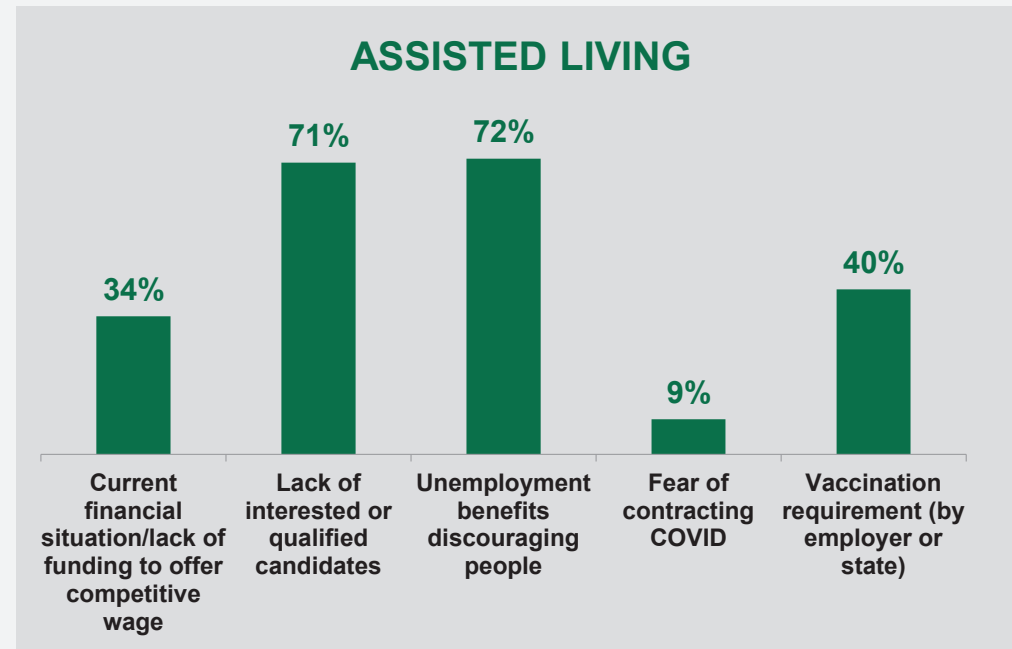
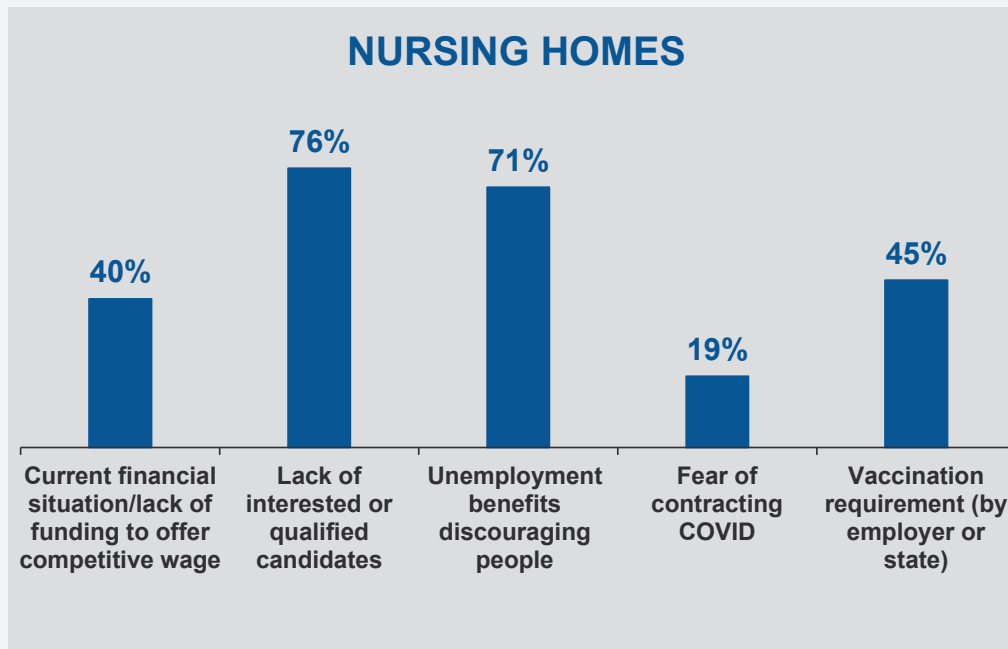


Source: American Health Care Association & National Center for Assisted Living Survey of 1,183 Nursing Home and Assisted Living Providers, September 2021



More than 7 out of 10 long term care facilities said a lack of qualified candidates and unemployment benefits have been the biggest obstacles in hiring new staff.

Q. What has been the biggest obstacle in hiring new staff?

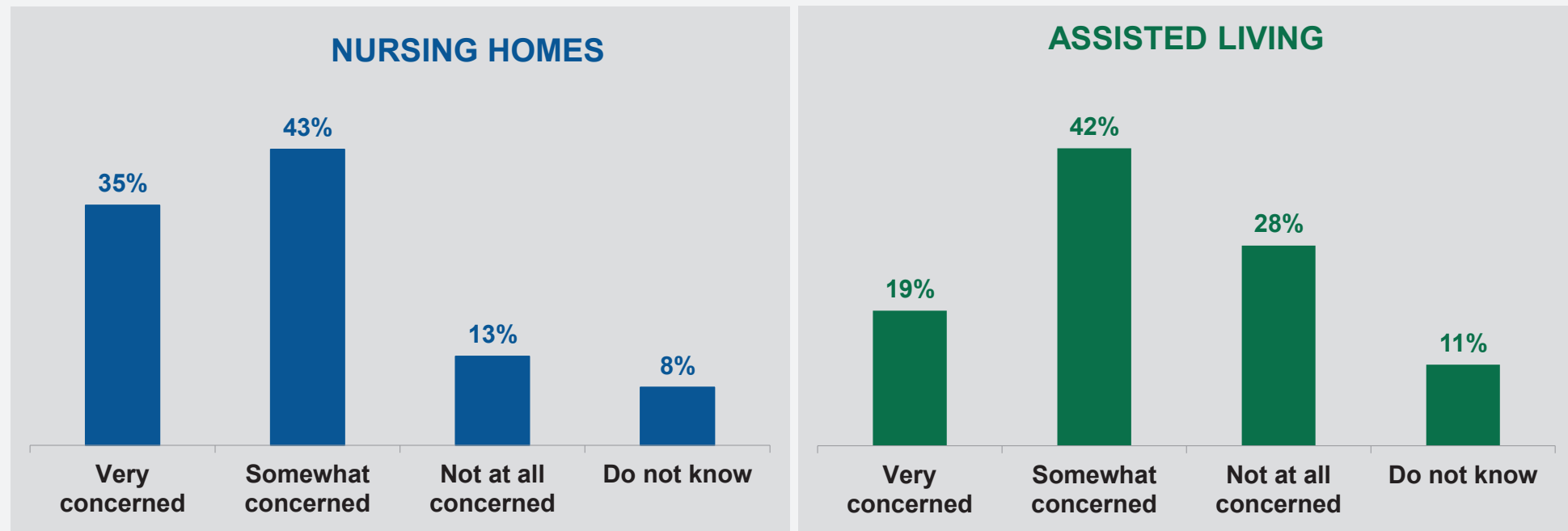


Source: American Health Care Association & National Center for Assisted Living Survey of 1,183 Nursing Home and Assisted Living Providers, September 2021



78% of nursing homes and 61% of assisted living communities are concerned workforce challenges might force them to close. More than one-third of nursing homes are very concerned about having to shut down their facility(ies).

Q. How concerned are you that if your workforce challenges persist that you may have to close your facility(ies)?



Source: American Health Care Association & National Center for Assisted Living Survey of 1,183 Nursing Home and Assisted Living Providers, September 2021

AR-03950

State-wide Genomic Epidemiology Investigations of COVID-19 Infections in Healthcare Workers – Insights for Future Pandemic Preparedness

Authors

Anne E. Watt^{1*}, Norelle L. Sherry^{1,2*}, Patiyan Andersson^{1*}, Courtney R. Lane¹, Sandra Johnson¹, Mathilda Wilmot¹, Kristy Horan¹, Michelle Sait¹, Susan A. Ballard¹, Christina Crachi¹, Dianne J. Beck¹, Caroline Marshall³, Marion Kainer⁴, Rhonda Stuart⁵, Christian McGrath⁶, Jason C. Kwong², Pauline Bass⁷, Peter G. Kelley⁸, Amy Crowe⁹, Stephen Guy^{10, 11}, Nenad Macesic¹², Karen Smith^{13,14}, Deborah A. Williamson¹⁵, Torsten Seemann^{1,15+}, Benjamin P. Howden^{1,2,15+}

* Equal contributors

+ Equal contributors

Affiliations

¹ Microbiological Diagnostic Unit Public Health Laboratory, Department of Microbiology & Immunology, University of Melbourne at the Peter Doherty Institute for Infection & Immunity, Melbourne, Victoria, Australia

² Department of Infectious Diseases, Austin Health, Heidelberg, Victoria, Australia

³ Victorian Infectious Diseases Service, Royal Melbourne Hospital, Parkville, Victoria, Australia

⁴ Department of Infectious Diseases, Western Health, Footscray, Victoria, Australia

⁵ Monash Infectious Diseases, Monash Health, Clayton, Australia

⁶ Department of Infectious Diseases, The Northern Hospital, Epping, Victoria, Australia

⁷ Infection Control Department Prevention and Healthcare Epidemiology, Alfred Health, Prahran, Victoria, Australia

⁸ Department of Infectious Diseases, Peninsula Health, Frankston, Victoria, Australia

⁹ Department of Microbiology, St Vincent's Hospital Melbourne, Fitzroy, Victoria, Australia

¹⁰ Department of Infectious Diseases, Eastern Health, Box Hill, Victoria, Australia

NOTE: This preprint reports new research that has not been certified by peer review and should not be used to guide clinical practice.

¹¹ Eastern Health Clinical School Monash University, Victoria, Australia

¹² Department of Infectious Diseases, Epworth Hospital, Richmond, Victoria, Australia

¹³ Centre for Research and Evaluation, Ambulance Victoria, Victoria, Australia

¹⁴ Department of Epidemiology and Preventive Medicine, Monash University, Victoria, Australia

¹⁵ Doherty Applied Microbial Genomics, Department of Microbiology & Immunology, University of Melbourne, Victoria, Australia

Corresponding author: Prof Benjamin Howden, Microbiological Diagnostic Unit Public Health Laboratory, Department of Microbiology & Immunology, University of Melbourne at the Peter Doherty Institute for Infection & Immunity, 792 Elizabeth St, Melbourne, Victoria, Australia 3000

Email: bhowden@unimelb.edu.au

Telephone: +61 3 8344 5701

Abstract

Background

COVID-19 has resulted in many infections in healthcare workers (HCWs) globally. We performed state-wide SARS-CoV-2 genomic epidemiological investigations to identify HCW transmission dynamics and provide recommendations to optimise healthcare system preparedness for future outbreaks.

Methods

Genome sequencing was attempted on all COVID-19 cases in Victoria, Australia. We combined genomic and epidemiologic data to investigate the source of HCW infections across multiple healthcare facilities (HCFs) in the state. Phylogenetic analysis and fine-scale hierarchical clustering were performed for the entire Victorian dataset including community and healthcare cases. Facilities provided standardised epidemiological data and putative transmission links.

Findings

Between March and October 2020, approximately 1,240 HCW COVID-19 infection cases were identified; 765 are included here. Genomic sequencing was successful for 612 (80%) cases. Thirty-six investigations were undertaken across 12 HCFs. Genomic analysis revealed that multiple introductions of COVID-19 into facilities (31/36) were more common than single introductions (5/36). Major contributors to HCW acquisitions included mobility of staff and patients between wards and facilities, and characteristics and behaviours of individual patients including super-spreading events. Key limitations at the HCF level were identified.

Interpretation

Genomic epidemiological analyses enhanced understanding of HCW infections, revealing unsuspected clusters and transmission networks. Combined analysis of all HCWs and patients in a HCF should be conducted, supported by high rates of sequencing coverage for all cases in the population. Established systems for integrated genomic epidemiological investigations in healthcare settings will improve HCW safety in future pandemics.

Funding

The Victorian Government, the National Health and Medical Research Council Australia, and the Medical Research Future Fund.

Introduction

The COVID-19 pandemic has resulted in the hospitalization of large numbers of patients with severe disease, particularly in older age groups.¹ Healthcare workers (HCWs) on the frontline have acquired COVID-19 in many different settings, often despite adequate availability and choice of appropriate personal protective equipment (PPE).²⁻⁶ To optimise the safety of HCWs and patients, it is critical for hospital infection control teams and, more broadly, healthcare systems to understand the drivers of infections in HCWs, through systematic investigations of the circumstances around these putative transmissions in healthcare settings. Internationally, genomics of SARS-CoV-2 has been a powerful tool for understanding transmission links and outbreaks.⁷⁻¹⁰ Whilst the investigation of HCW infections has traditionally been achieved through epidemiologic assessments, combined genomic and epidemiologic analyses have now emerging as the new standard-of care for these investigations.^{11,12}

The state of Victoria, Australia (population ~6.7 million)¹³ experienced two waves of COVID-19 in 2020. Comprehensive prospective genomic sequencing of SARS-CoV-2-positive samples was undertaken by the public health genomic reference laboratory (the Microbiological Diagnostic Unit – Public Health Laboratory (MDU-PHL)), with samples sequenced from 75% of cases. The first wave was largely a polyclonal outbreak, characterised by multiple introductions from overseas travellers with limited onwards transmission in the population, and very limited transmission to HCWs.^{6,14} The second wave in Victoria was largely a clonal outbreak, centred in Melbourne, Victoria, originating from a breach in the hotel quarantine system for returned travellers.⁷ This second wave resulted in outbreaks occurring across many healthcare facilities (HCF) and aged care facilities (ACF).⁷ Globally, HCWs are at increased risk of infection with coronavirus disease (COVID-19).² Multiple studies are beginning to document nosocomial transmission and infection in HCWs^{11-12,15-16} and highlighting the need for tailored infection control investigations and responses. Whole genome sequencing can contribute high resolution data to describe and investigate such transmission networks.

Here we describe the process and findings of investigations of HCW infections in multiple HCFs across our state. We hypothesised that an integrated genomic epidemiological analysis of COVID-19 HCW infections, interpreted in the broader context of all healthcare and community infections, would enhance understanding of the source of HCW infections and identify common transmission risks. Our results aim to provide a framework for workflows and metadata required to maximise HCF preparedness to investigate COVID-19 HCW infections, and optimise staff safety for future outbreaks.

Methods

Setting and data sources

This project was undertaken in the state of Victoria, Australia (population ~6.7 million),¹³ where the healthcare network includes eleven major metropolitan health services. Since the start of the COVID-19 pandemic, all samples positive for SARS-CoV-2 by RT-PCR are requested to be forwarded to MDU-PHL for genomic sequencing.^{7,14,17} Prospective sequencing was conducted on all samples received at MDU-PHL, with samples sequenced from approximately 75% of cases.⁷

The genomic epidemiology team at MDU-PHL assisted all HCFs requesting genomic investigations of COVID-19 outbreaks in HCWs (and often including patients) in their facilities. Investigations were conducted to inform operational improvements at each healthcare facility, including infection prevention and control, for infection control purposes, with each healthcare facility providing the epidemiological data to inform the genomic epidemiological investigation. Investigations were an iterative process developed through collaboration with healthcare facilities, refined to a standard workflow and list of required and desirable metadata (Box. 1). Some of these investigations were conducted in near to real time whilst others were requested retrospectively once capacity was available at the HCF to perform the epidemiological assessment. For this study, HCWs were defined as any staff, students or volunteers working in a hospital or paramedic setting, excluding community residential aged care facilities (RACFs).

Genomic data and bioinformatic analysis

Detailed methods are described elsewhere;^{7,14} briefly, extracted RNA from SARS-CoV-2 RT-PCR positive samples underwent tiled amplicon PCR using either ARTIC version 1 or 3 primers,¹⁸ following published protocols.¹⁹ Reads were aligned to the reference genome (Wuhan Hu-1; GenBank MN908947.3) and consensus sequences generated. Quality control (QC) metrics on consensus sequences included requiring $\geq 65\%$ genome recovered, ≤ 35 single nucleotide polymorphisms (SNPs) from the reference genome, and ≤ 300 ambiguous or missing bases. A single sequence was selected from each patient for phylogenetic analysis. Genomic clusters were defined as two or more related sequences using a complete-linkage hierarchical clustering algorithm of pairwise genetic distances derived from a maximum likelihood phylogenetic tree. Genomic clustering was used to identify plausible genomic links between cases, which were further interpreted together with epidemiological data.

Combined genomic and epidemiologic analysis

Genomic epidemiological analyses were performed in three stages (**Box 1**). Beginning with a line list from HCFs identifying HCW and patients with sufficient identifiers to match to available lab and

genomic data. Stage one linked cases with samples and grouped cases by genomic cluster, identifying the minimum number of genomic introductions likely to have taken place, and formed the foundation for all further investigations. Stage two expanded the investigation by including the case information such as date of sample collection, symptom onset and diagnosis for each individual. The results of this step allowed for focusing of further epidemiological investigations. Stage three provided in-depth epidemiological investigation of genomic clusters by combining epidemiological location and exposure data.

Results of each analysis were reported to the facilities as an iterative process, with collaborative meetings cases included in the analysis were reviewed, then the genomic data were presented. Facilities were given the opportunity to review and add any epidemiological data to assist with the analysis and to put forward any specific queries based on their epidemiological analysis. The analyses were then refined based on the outcomes of the meetings and compiled into a final report.

Ethics

Ethical approval was received from the University of Melbourne Human Research Ethics Committee (study number 1954615.4).

Results

Between March and October, 2020, MDU-PHL were approached by 12 HCFs to assist with genomic epidemiological investigations into HCW COVID-19 cases. Investigations ranged in scope from individual suspected transmission events to ward- or facility-level investigations. MDU-PHL assisted with 36 investigations, with 9/12 facilities requesting more than one investigation. The majority of investigations were undertaken in large public university hospitals, with a small number of private facilities, including a total of 21 campuses and more than 9900 beds,²⁰ as well as the metropolitan paramedic service. A total of 765 HCWs and 1,273 patients were investigated, with sequencing available for 80% (612) of HCWs and 80.8% (1,028) of patients (data summarized in **Table 1**).

For the five healthcare networks where we performed analyses across the whole institution (all campuses), an estimated 59% to 80% of HCW infections were deemed to be likely acquired at the HCF.

Genomic results often, but not always, had high concordance with epidemiologic investigations

Genomic analysis provides an estimation of the minimum number of introductions to a facility through the number of genomic clusters present. The median number of introductions in these analyses was 3 per facility (IQR 2 - 8, range 1 – 35) and the median number of HCWs per genomic cluster was 1 (IQR 1-3, range 1 – 104). These analyses found that 31/36 (86.1%) investigations included cases resulting from multiple introductions, while 5/36 (13.9%) investigations involved a single introduction. Investigations with multiple introductions had a median of 6 HCWs (IQR 1 – 17, range 1 - 237) and 7 patients (IQR 3 – 39 range 1 - 395) while investigations with single introductions had a median of 1 HCW (IQR 1 – 6, range 1 – 7) and 2 patients (IQR 1 – 36, range 1 – 56). Thirteen of these analyses were instances of investigations into single staff members and their contacts; three of these could not be resolved as sequence data for the case or contacts was unavailable. While it is more likely to have multiple genomic introductions when there are high case numbers present at a facility, we found that low case numbers did not always result in fewer genomic introductions.

In these investigations, we largely observed high levels of concordance between epidemiological hypotheses (healthcare acquired infection or not) and genomic data where transmission had occurred, with some notable exceptions. One , a multi-campus facility, epidemiologically identified multiple individual outbreaks within their campuses. The combined genomic epidemiological analysis found undetected transmission events and that most of the individual outbreaks and unlinked cases were linked back to a single introduction or source (**Figure 1, A**). Conversely, Facility B experienced a large outbreak at one campus; genomics identified three concurrent outbreaks from separate genomic clusters at a time of high community prevalence (**Figure 1, B**). In both cases, genomic data significantly altered the understanding of transmission in the facilities, leading to changes in infection control practices. For example, at one HCF, upon reviewing the epidemiology in the light of the genomic data it become clear

that some epidemiological links were missed, highlighting the need to strengthen contact tracing applications and resources for this facility.

Mobility of HCWs and patients often implicated in hospital transmissions

A common theme from HCFs was that many infections resulted from the mobility of staff or patients. Movement of staff and patients between wards and campuses while pre-symptomatic or asymptomatic was implicated in dissemination of COVID-19 between facilities within hospital networks (4/8 facilities where multiple campuses were investigated). At one facility, a single patient was found to have seeded cases in two wards due to transport while asymptomatic. Their movement between general and rehabilitation wards resulted in spread to 5 naïve patients and 15 HCWs. Identification of spread due to patient mobility led to one HCF to introduce asymptomatic testing for any patient moving from acute to subacute ward during periods of high community transmission.

Patient features or behaviours contributing to COVID-19 transmission to HCWs

In the course of these investigations, elderly patients with altered mental states were found to exhibit behaviours that contributed to the spread of COVID-19 within at least four HCFs. Patients suffering from delirium or dementia were often highly mobile (wandering behaviours) and exhibiting aerosol-generating behaviours (coughing, shouting or singing). Due to the nature of these patients and their increased need of HCW support, direct contact was often implicated in the transmission. In these cases, combined genomic and epidemiological data showed that one or more patients, admitted from a single ACF at the same time, were found to be the likely acquisition source for staff that contracted COVID-19 working on a ward for COVID-19 positive patients with dementia or delirium.

Limiting the scope of investigations may lead to erroneous conclusions

Investigations limited to a single ward were found to have limited utility when performed at large facilities with high numbers of positive cases. These investigations often found cases without any known transmission source, transmission, with multiple outbreaks deemed separate by epidemiological investigations, subsequently identified as single outbreaks by genomics. For example, investigation of a ward-based outbreak at one facility identified eight genomically-linked cases. An expanded investigation, including all HCWs and patients at the facility in a similar time, identified an additional 10 cases were part of the same genomic transmission network as the first ward, indicating that cryptic transmission had likely occurred from the first ward analysed, and providing opportunities for further targeted epidemiologic investigations (**Figure 2**).

Similarly, limitations were found when examining investigations without contemporaneous genomic data from community cases. Lack of sufficient community cases for context can lead to inaccurate interpretation of transmission events. Initial investigations performed for one Facility C without community context indicated likely transmission between HCWs in a work setting. The same data, when interpreted with community context, indicated that transmission was more likely to have occurred in a social setting external to the workplace, and confirmed by further epidemiologic investigations (**Figure 3**).

Key learnings for genomic investigations of HCW infections

The collaborative meetings with HCFs provided an opportunity to educate clinicians about the utility and limitations of genomic analyses, share initial findings from the genomic analysis, add additional relevant epidemiological data to assist with interpretation, gauge the understanding of the genomic results and clarify further where necessary. They also provided an opportunity for additional epidemiological data that may have been missed during data collection, such as data on social links between cases e.g., staff often socialised together after working hours or lived in shared housing with other HCWs that maybe from the same or other HCFs, which is difficult to capture in standard line lists shared as part of the early investigation process. Anecdotally, one HCF identified that 50% of their HCWs lived with other HCWs.

Discussion

The COVID-19 pandemic has reinforced the need to optimise HCF systems to protect both patients and HCWs from infectious diseases threats.²¹ Here we detail genomic epidemiological investigations undertaken by a reference public health genomics laboratory of COVID-19 infections in HCWs across multiple facilities in Victoria, Australia and define a framework for this type of activity in future. Through an iterative, collaborative process with 12 HCFs, we performed 36 investigations for 765 HCWs out of a total of 1240 HCW infections notified for the state.²² Underpinning these analyses was efficient case ascertainment and a very high proportion of positive cases sequenced, including samples from HCWs and patients as well as the community. Several of these investigations were conducted in near to real time which allowed facilities to rapidly change infection prevent protocols to limit further spread. A clear strength of the investigative process in this study was establishing a forum of laboratory and clinical experts to initiate, discuss and progress investigations which facilitate the integration of genomic results with infection prevention and control methods.

This study highlights important commonalities that were seen across the facilities investigated and the importance of understanding SARS-CoV-2 transmission for future outbreak prevention. We found that physical movement of individuals as well as aerosol generating behaviours led to known and cryptic transmission of COVID-19 within the facilities we investigated. While this pattern of staff and patient movement is likely ubiquitous to HCFs and has been seen to contribute to the spread of COVID-19 elsewhere,^{11,12} it highlights the importance of investigating all positive cases of HCWs and patients within a facility. We noted instances such as at Facility A, where the genomic data refuted the findings of the epidemiologic data, interpretation of the two data sets together would significantly change the infection control response. Similar scenarios were found by Meijer et al.²³

While genomic analyses can be informative with basic epidemiological data, the rich detail added by comprehensive epidemiological data dramatically improves their utility. Rapid and effective data capture and management was a significant challenge for most facilities during the epidemic, delaying and limiting infection control investigations; implementation of sustainable continuous data collection processes within HCFs should be a priority for future epidemic preparedness, allowing earlier initiation of epidemiological and genomic investigations.

Based on our experiences, we propose a set of minimum and enhanced metadata and a workflow to optimise the utility of HCW investigations (**Box 1**), recognising that expansion and resourcing for such systems can vary between facilities. Wherever possible, integration with existing data systems should be leveraged, such as data from employee databases. Metadata should be collected in standardized templates, and captured in a secure version-controlled database (e.g. REDCap). This maintains data integrity during staff turnover or when surge capacity is called for in response to events. The World Health Organisation (WHO) has outlined the minimum metadata to ensure that genomic sequencing of SARS-CoV-2 samples will be of most use.²⁴ From our experiences here, we propose that these metadata

should ideally be expanded when performing genomic epidemiological analysis. To allow for rapid utilisation of data when the need arises, prior consideration should be given to the governance framework for the use and integration of the data into other systems, such as disclosure to public health laboratories during investigations, and its relationship to data captured by other public health organisations.

Limitations of the study include the highly clonal nature of cases in Victoria at this time, with >95% of cases from the second wave being seeded for a single event. This limited the ability to resolve some transmission networks, particularly early in the outbreak, and may erroneously suggest single introductions of a cluster when there may have been multiple introductions from a genomic cluster from the community. This increases the importance of quality epidemiologic data to assist with interpretation of genomic data when performing these analyses. Our investigations were also limited by HCW and patient cases that were not able to be sequenced although numbers were relatively small, and the proportion of cases successfully sequenced was greater than most other jurisdictions. Similar processes could easily be applied to other healthcare systems where genomics is less commonly available; in particular, focussed sequencing of hospitalised cases and HCWs could achieve very similar results, albeit with a small chance of false-positive genomic links due to multiple introductions of the same genomic cluster from the community.

The results from each facility have shown that there were multiple contributors to COVID-19 infections in HCWs in Victoria in 2020, and that while there were common factors contributing to transmission across different facilities, each outbreak was in fact a unique combination of contributors and had to be assessed individually. Through our experience working with multiple HCFs, we found that it was essential to investigate all positive HCW and patient cases in a facility along with detailed epidemiological data, wherever feasible. Collaborative and interactive exploration of the combined data uncovered further epidemiological links, maximising the impact of the analyses for the HCF, and providing the greatest opportunities for HCFs to optimise the safety of HCWs and patients in the future.

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Data sharing

All consensus sequences and Illumina sequencing reads are available at <https://github.com/MDU-PHL/COVID19-paper>.

Competing Interest

All authors declare no competing interests and confirm that authors or their institutions have not received any payments or services in the past 36 months from a third party that could be perceived to influence, or give the appearance of potentially influencing, the submitted work

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Figures:

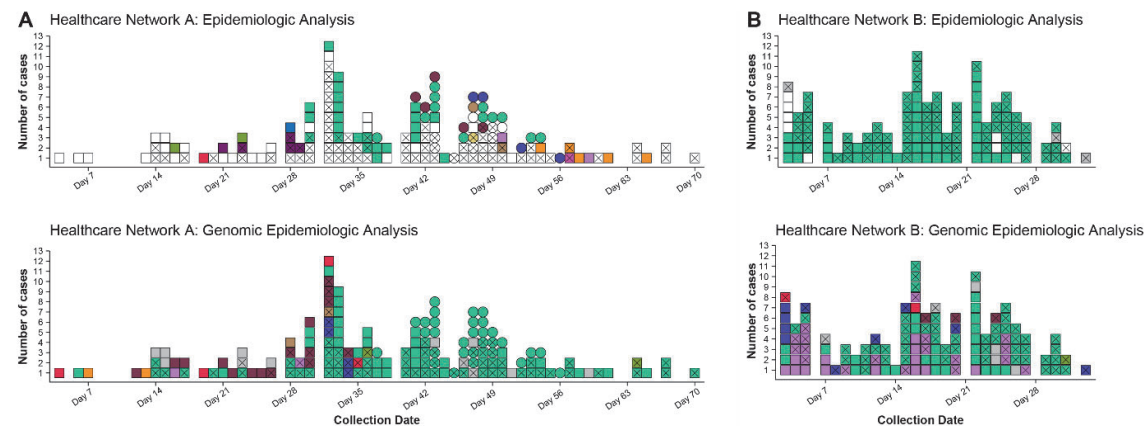


Figure 1 . Comparison of clustering (identifying cases of HCW and patient infections that are likely to be related) by epidemiology and genomics analyses at two facilities. Colour indicates cluster (epidemiological cluster for epidemiologic analyses and genomic cluster for genomic epidemiological analyses); white indicates unknown cluster/acquisition; grey indicates non-healthcare acquired infection; X indicates HCW case; squares and circles in panel A indicate two different campuses of the healthcare network. ‘Collection date’ refers to day of the outbreak period for each panel. **Panel A.** Epidemiological analysis of COVID-19 cases at Facility A (two separate campuses) identified 12 epidemiologic clusters of likely transmission and 88 cases with no known acquisition source. Genomic epidemiologic analysis for the same network showed that the vast majority of cases were linked within eight genomic clusters, including one dominant cluster (lighter green), and only 12 cases not genomically linked to the HCF. **Panel B.** Epidemiological analysis of cases at Facility B identified >100 HCW cases likely acquired at the facility, all thought to be part of a single epidemiologic cluster, and nine HCW cases not thought to be healthcare acquired. Genomic epidemiologic analysis indicated multiple introductions, rather than a single introduction, with six different genomic clusters co-occurring, and only six cases not genomically-linked to the HCF.

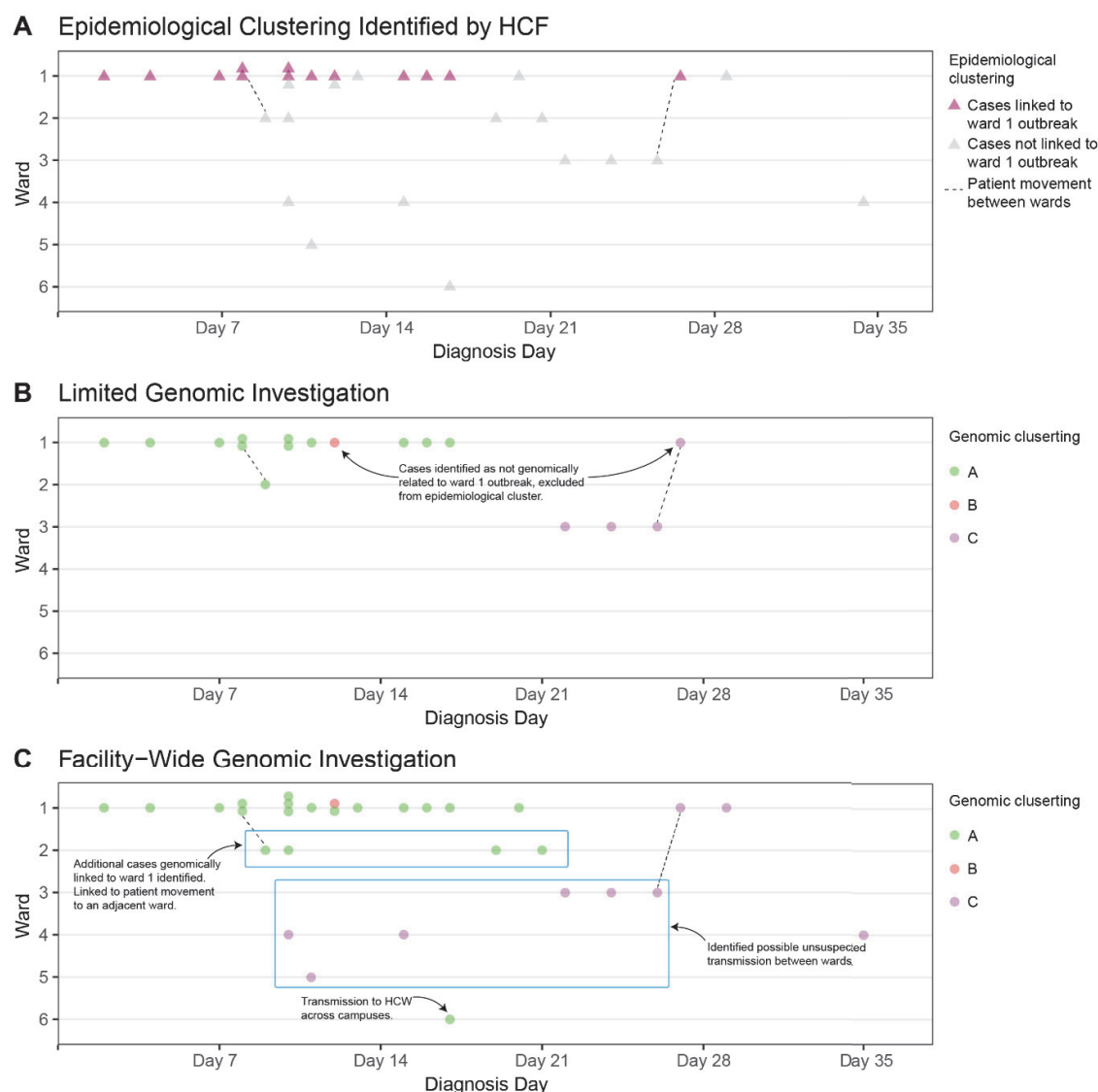


Fig 2. Comparison of clustering (identifying cases of HCW and patient infections that are likely to be related) at one multi-campus healthcare facility using three different models: epidemiological clustering (panel A), limited genomic investigation (cases in a single ward selected by HCF, panel B), and facility-wide genomic infections (panel C). Each panel shows the distribution of cases (triangles in panel A, circles in panels B and C) across six different wards (Wards 1-6) over a six-week time period in 2020, where ‘Diagnosis day’ refers to the day in the outbreak period. In **panel A**, thirteen cases were identified by the HCF as a likely epidemiologic cluster (pink triangles). These cases, with the addition three cases from adjacent ward (Ward 3) were submitted for a limited genomic investigation (**panel B**); cases (circles) are coloured by genomic cluster. This showed that most of the cases submitted were part of the same genomic cluster, but two of the Ward 1 cases were not linked (one case from GC B, and one case from GC C, which was linked to two other cases on Ward 3). **Panel C** shows a broader facility-wide genomic investigation that was undertaken to investigate cases on other wards; all HCW and patient cases were included in the facility-wide investigation. This genomic analysis found the main

outbreak from Ward 1 was larger than first identified, linking outbreaks in adjacent wards to the Ward 1 outbreak, with cryptic transmission between wards resulting in spread, including transmission to another hospital campus. Unexpected links were also identified for GC C, with cases spread over four wards. These genomic links were used to direct further investigations to identify causes of transmission and introduce mitigation strategies.

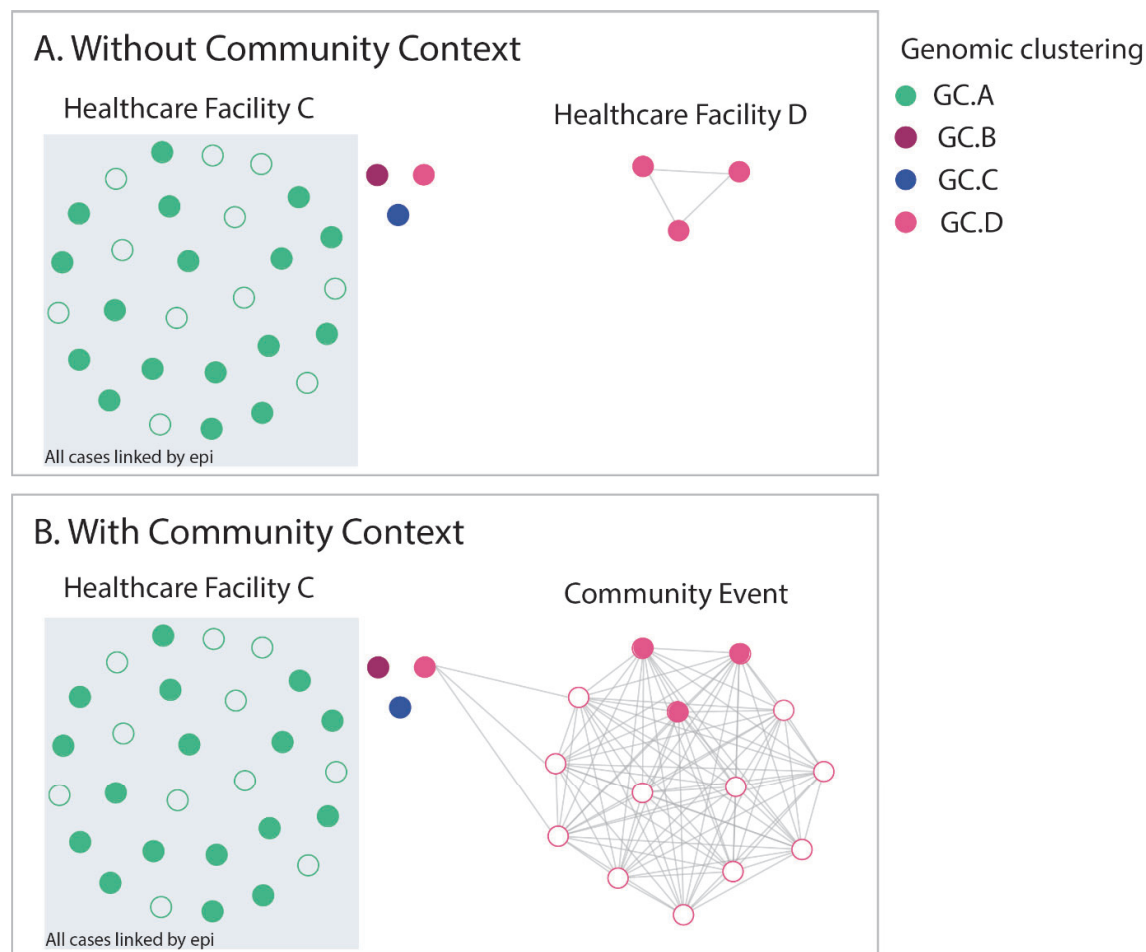


Fig 3. Comparison of genomic epidemiological analyses analysed with and without genomic data for community cases. Filled circles indicate HCWs, unfilled circles indicate non HCWs, colour indicates genomic cluster. **Panel A** shows analysis of cases from facility C (mostly linked by epidemiology and genomics with dominant genomic cluster GC A (green), and three additional HCW cases from different genomic clusters (genomic clusters GC B, GC C and GC D), plus three cases at facility D (related to each other) from genomic cluster GC D. In isolation, this suggests possible cryptic transmission between the two healthcare facilities. Addition of community sequences into the analysis (**Panel B**) demonstrated that the HCWs at both facility C and facility D likely acquired infection from a social event in the community that was attended by these cases.

Table 1 Summary of the 36 genomic epidemiological investigations

	HCW	Patients
Total - N	765	1273
Samples received at MDU-PHL – N (%)	674 (88.1)	1144 (89.9)
Sequences available – N (%)	612 (80.0)	1028 (80.0)
Number per investigation – Median (Range)	6 (1-237)	4 (1-395)

No. of HCF		12
Total no. of beds		>9900 (median 159.3, range 14 – 704)
Characteristics	No. of campuses	21
	Public acute care	14
	Public subacute care	6
	Large private hospital	1
	Paramedic Services	Multiple locations

BOX 1 Genomic Epidemiological Investigations

Part 1 – Establishing basic genomic and epidemiologic data

1. Establish HCF transmission hypotheses for investigation
2. Collect case list and metadata (demographic & case information).
3. Identify missing data, follow up on sample and sequencing availability.
4. Build phylogenetic tree with suitable context isolates (temporal & geographic).
5. Match metadata to available genomic data.
6. Discuss genomic clustering with HCF.
 - a. Optional stopping point

Part 2 – Integrating case information

7. Overlay detailed epidemiological metadata (date of diagnosis, and patient/staff role)
8. Discuss with HCF the concordance between epidemiological data and phylogenetic data.

Part 3 – Integrating exposure and location data

9. Overlay detailed epidemiological location data & exposure data (known exposure events)
10. Refine genomic clustering with detailed epidemiological metadata.
11. Final written report.

Optimal metadata to include:

Individual level metadata

1. Demographic data
 - a. Name
 - b. Date of birth
 - c. Lab / UR number
2. Case information
 - a. Date of diagnosis, Date of onset, Date of collection
 - b. Role - HCW (with or without patient contact; specific role) / Patient / Visitor
3. Location data
 - a. Patient admission date, ward and bed number and movement details
 - b. Staff shift dates, primary and secondary locations (where available)
 - c. Furlough
4. Exposure data
 - a. Known COVID positive contacts with dates of contact
 - b. PPE breach or other known high-risk events – positive cases, contact level
 - c. Staff links to other HCF or ACF
 - d. Travel History international and local
 - e. Contact with other staff outside the workplace e.g. car-pooling or social events Staff living with / links to other HCW ACW
 - f. Residence in or exposure to community “hotspot” (a location of intense community transmission)

Facility level metadata

- a. PPE donning and doffing procedures /locations
- b. Staff facilities, e.g. shared team rooms
- c. Facility links to other HCF or ACF

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Summary Document for Interim Clinical Considerations

for Use of COVID-19 Vaccines Currently Authorized or Approved in the United States



	Pfizer-BioNTech		Moderna	Janssen
Vaccine type	mRNA		mRNA	Replication-incompetent adenovirus type 26 vector
Age groups	5 through 11 years of age	12 years of age and older	≥18 years	≥18 years
Dose	10 µg (orange cap)	30 µg (purple cap)	100 µg (primary series and additional primary dose) 50 µg (booster dose)	5×10 ¹⁰ viral particles
Dosage (volume)	0.2 mL	0.3 mL	0.5 mL (primary series and additional primary dose) 0.25 mL (booster dose)	0.5 mL
Number of doses in primary series	2		2	1
Interval between primary series doses	3 weeks (21 days)		1 month (28 days)	N/A
Additional primary dose for moderately or severely immunocompromised persons	Currently not authorized or recommended for this age group	Recommended at least 28 days after the 2nd dose of the primary series for <u>moderately and severely immunocompromised people</u> 12 years of age and older (https://www.cdc.gov/vaccines/covid-19/clinical-considerations/covid-19-vaccines-us.html#considerations-covid-19-vax-immunocompromised). Use the same vaccine product as the primary series. See information below about a booster dose.	Recommended at least 28 days after the 2nd dose of the primary series for <u>moderately and severely immunocompromised people</u> 18 years of age and older (https://www.cdc.gov/vaccines/covid-19/clinical-considerations/covid-19-vaccines-us.html#considerations-covid-19-vax-immunocompromised). Use the same vaccine product as the primary series. See information below about a booster dose.	Not authorized as an additional primary dose. See information below about a booster dose.
Booster dose	Currently not recommended for this age group	<p>A booster dose at least 6 months after the completed primary series (or additional primary dose for moderately or severely immunocompromised) should be given for:</p> <ul style="list-style-type: none"> ■ People aged 65 years and older ■ People 50-64 years of age with underlying medical conditions (https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html) ■ Residents 18 years of age and older in long-term care settings, including moderately and severely immunocompromised persons ■ People 50 years of age and older who are moderately to severely immunocompromised <p>A booster dose at least 6 months after the primary series (or additional primary dose for moderately or severely immunocompromised) may be given based on their individual benefits and risks for:</p> <ul style="list-style-type: none"> ■ People 18-49 years of age with underlying medical conditions (https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html) ■ People aged 18-64 years of age at increased risk for SARS-CoV-2 exposure and transmission because of occupational or institutional settings ■ People 18-49 years of age who are moderately to severely immunocompromised and do not reside in a long-term care setting <p>For moderately and severely immunocompromised persons, the booster dose may be given after an additional (3rd) primary series dose (for a total of 4 doses) For additional information, see Interim Clinical Considerations for Use of COVID-19 Vaccines Currently Approved or Authorized in the United States https://www.cdc.gov/vaccines/covid-19/clinical-considerations/covid-19-vaccines-us.html#considerations-covid19-vax-immunocompromised</p> <p>The booster dose may be a different vaccine product than the primary series.</p>		<p>A single booster dose should be administered to all people 18 years and older who received a primary single-dose Janssen COVID-19 Vaccine*</p> <p>A moderately or severely immunocompromised person who received a primary Janssen COVID-19 Vaccine should not receive more than 1 booster dose (total of 2 doses)</p> <p>The booster may be a different vaccine product than the primary series</p>
Interval between primary and booster doses	n/a	At least 6 calendar months after completing the primary series or additional primary dose (for moderately or severely immunocompromised)	At least 6 calendar months after receiving the primary series or additional primary dose (for moderately or severely immunocompromised)	At least 2 months (8 weeks) after receiving the primary dose

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All currently authorized or approved COVID-19 vaccines

Interchangeability of vaccines	<ul style="list-style-type: none"> Primary series doses and additional primary dose (for moderately and severely compromised people) should be with the same mRNA vaccine product. In exceptional situations for people ≥ 18 years, such as a contraindication to a second dose of mRNA vaccine or when a previous dose product cannot be determined or is not available, another mRNA FDA- approved or -authorized COVID-19 vaccine may be used (administer at a minimum interval of 28 days). The Pfizer-BioNTech formulation for children aged 5-11 years (orange cap) is not interchangeable with the Pfizer-BioNTech formulation for people aged ≥ 12 years (purple cap). Any FDA-approved or -authorized COVID-19 vaccine can be used for the booster dose. When a different product is used, the eligible population and dosing intervals are those of the vaccine used for the primary series. (https://www.cdc.gov/vaccines/covid-19/clinical-considerations/covid-19-vaccines-us.html#Interchangeability).[†]
Coadministration with other vaccines	<ul style="list-style-type: none"> COVID-19 vaccines may be administered without regard to timing of other vaccines, including simultaneous administration.
Persons with prior or current COVID-19	<ul style="list-style-type: none"> COVID-19 vaccines can be given safely to people with prior SARS-CoV-2 infection Defer vaccination until person has recovered from the acute illness and criteria have been met for them to discontinue isolation (https://www.cdc.gov/coronavirus/2019-ncov/hcp/disposition-in-home-patients.html)
Multisystem inflammatory syndrome (MIS-C and MIS-A)	<ul style="list-style-type: none"> COVID-19 vaccines can be given; however, a conversation between the patient, guardian, and clinical team to discuss benefits and risks of receiving a COVID-19 vaccine is encouraged.
Persons who received monoclonal antibodies or convalescent plasma for COVID-19 treatment or post-exposure prophylaxis	<ul style="list-style-type: none"> For post-exposure prophylaxis: defer COVID-19 vaccination for 30 days For COVID-19 treatment: defer COVID-19 vaccination for 90 days
Persons with a known SARS-CoV-2 exposure	<ul style="list-style-type: none"> COVID-19 vaccine not recommended for community outbreaks or post-exposure prophylaxis. People in community or outpatient setting should defer vaccination until quarantine period has ended (https://www.cdc.gov/coronavirus/2019-ncov/if-you-are-sick/quarantine.html) Residents or patients in congregate settings may be vaccinated if they do not have symptoms consistent with COVID-19 (https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html)
Women aged <50 years Risk of thrombosis with thrombocytopenia syndrome (TTS)	<ul style="list-style-type: none"> Can receive any FDA-authorized or approved vaccine but should be informed of risk of TTS after receipt of Janssen (Johnson & Johnson) COVID-19 Vaccine and the availability of other COVID-19 vaccine options[*]
History of heparin-induced thrombocytopenia (HIT)	<ul style="list-style-type: none"> If within 90 days of illness, offer an mRNA vaccine, vaccinate with any FDA-authorized or approved COVID-19 vaccine, including Janssen COVID-19 Vaccine
Persons with underlying conditions	<ul style="list-style-type: none"> May receive COVID-19 vaccine
Persons receiving HCT and CAR-T-cell therapy	<ul style="list-style-type: none"> If received doses of COVID-19 vaccine prior to receiving an HCT or CAR-T cell therapy, should be revaccinated with a primary series at least 3 months (12 weeks) after transplant or CAR-T-cell therapy
Persons with a history of myocarditis or pericarditis	<ul style="list-style-type: none"> If myocarditis or pericarditis occurred after a dose of an mRNA COVID-19 vaccine: <ul style="list-style-type: none"> Until additional safety data are available, some experts recommend the Janssen COVID-19 Vaccine be given to persons aged ≥ 18 years who want to receive a subsequent dose. This decision should include a conversation between the patient and their clinical team. If a history of myocarditis or pericarditis unrelated to an mRNA COVID vaccination, may receive COVID-19 vaccine after the episode has completely resolved. A subsequent dose can be considered in certain circumstances including personal risk of severe COVID-19 and level of community transmission.

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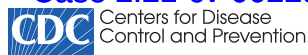


All currently authorized or approved COVID-19 vaccines

Persons with a history of Guillain-Barré Syndrome (GBS)	<ul style="list-style-type: none"> Can receive any FDA-authorized or approved COVID-19 vaccine; however, discuss the availability of mRNA vaccines because of possible association between GBS and Janssen COVID-19 vaccination.
Pregnant or breastfeeding people or people trying to get pregnant	<ul style="list-style-type: none"> Are recommended to receive a COVID-19 vaccine primary series, "additional primary dose (if indicated) and booster dose", inform of risk of TTS after receipt of Janssen COVID-19 Vaccine and the availability of other options
Children and adolescents	<ul style="list-style-type: none"> Children and adolescents aged 5-17 are ONLY eligible for Pfizer-BioNTech COVID-19 Vaccine Children aged 5-11 years - 10 ug (0.2mL dosage) Pfizer-BioNTech (orange cap) Adolescents aged ≥ 12 years - 30ug (0.3 mL dosage) Pfizer-BioNTech (purple cap) Adolescents and adults aged 18 years and older are eligible for all COVID-19 vaccine product Additional primary doses are not recommended at this time for children <12 years of age who are moderately or severely immunocompromised. Booster doses are not recommended for people <18 years of age https://www.cdc.gov/vaccines/covid-19/clinical-considerations/covid-19-vaccines-us.html#considerations-covid19-vax-booster Because of the risk of syncope, especially in adolescents, recipients should be observed for 15 minutes after vaccination
Persons vaccinated outside the United States	<ul style="list-style-type: none"> Received all recommended doses of an FDA-authorized or approved COVID-19 vaccine, do not need primary series doses; if only one dose of a two-dose vaccine has been received provide the second dose as close to the recommended time as possible. Received a non-FDA-authorized or -approved vaccine <ul style="list-style-type: none"> If vaccine is listed for emergency use by the World Health Organization (WHO) and received all recommended doses, do not need any additional primary series doses with an FDA-authorized or approved vaccine If vaccine is listed for emergency use by WHO, but has not received all recommended doses, may be offered a complete FDA-authorized or -approved series If vaccine is not listed for emergency use by WHO, may be offered a complete FDA-authorized or approved COVID-19 vaccine series If received a mixed dose regimen of FDA-approved, FDA-authorized, or WHO-emergency use listed COVID-19 vaccine for primary series, do not need any primary series doses. See detailed guidance: https://www.cdc.gov/vaccines/covid-19/clinical-considerations/covid-19-vaccines-us.html#people-vaccinated-outside-us
Contraindications	<ul style="list-style-type: none"> Severe allergic reaction (e.g., anaphylaxis) after a previous dose or to component of the COVID-19 vaccine Contradiction to one type of COVID-19 vaccines (mRNA) is a precaution to other types of COVID-19 vaccines (Janssen)
Precaution	<ul style="list-style-type: none"> Immediate (within 4 hours exposure) non-severe allergic reaction to a previous dose or known (diagnosed) allergy to a component of the vaccine Immediate allergic reaction to any other vaccine or injectable therapy (i.e., intramuscular, intravenous, or subcutaneous vaccines or therapies [excluding subcutaneous immunotherapy for allergies, i.e., "allergy shots"])
Post-vaccination observation periods	<ul style="list-style-type: none"> 30 minutes: people with a history of: <ul style="list-style-type: none"> A contraindication to another type of COVID-19 vaccine product (i.e., mRNA or viral vector COVID-19 vaccines) Immediate (within 4 hours of exposure) non-severe allergic reaction to a COVID-19 vaccine Immediate allergic reaction of any severity to a non-COVID-19 vaccine or injectable therapies Anaphylaxis due to any cause 15 minutes: all other persons
SARS-CoV-2 antibody testing	<ul style="list-style-type: none"> Antibody testing not recommended for vaccine decision-making or to assess immunity following vaccination

*Any person who develops TTS after a Janssen primary dose should NOT get a Janssen booster.

† Although CDC provides considerations for a mixed series in exceptional circumstances for a primary or additional primary dose (<https://www.cdc.gov/vaccines/covid-19/info-by-product/clinical-considerations.html#interchangeability>), this is still considered an administration error that requires VAERS reporting. Heterologous booster doses are allowed and are not considered a vaccine error.



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Mark W. Tenforde, MD, PhD^{1,*}; Wesley H. Self, MD^{2,*}; Eric A. Naioti, MPH¹; Adit A. Ginde, MD³; David J. Douin, MD³; Samantha M. Olson, MPH¹; H. Keipp Talbot, MD²; Jonathan D. Casey, MD²; Nicholas M. Mohr, MD⁴; Anne Zepeski, PharmD⁴; Manjusha Gaglani, MBBS^{5,6}; Tresa McNeal, MD⁵; Shekhar Ghamande, MD⁵; Nathan I. Shapiro, MD⁷; Kevin W. Gibbs, MD⁸; D. Clark Files, MD⁸; David N. Hager, MD, PhD⁹; Arber Shehu, MD⁹; Matthew E. Prekker, MD¹⁰; Heidi L. Erickson, MD¹⁰; Michelle N. Gong, MD¹¹; Amira Mohamed, MD¹¹; Daniel J. Henning, MD¹²; Jay S. Steingrub, MD¹³; Ithan D. Peltan, MD¹⁴; Samuel M. Brown, MD¹⁴; Emily T. Martin, PhD¹⁵; Arnold S. Monto, MD¹⁵; Akram Khan, MD¹⁶; Catherine L. Hough, MD¹⁶; Laurence W. Busse, MD¹⁷; Caitlin C. ten Lohuis, ACNP-BC¹⁷; Abhijit Duggal, MD¹⁸; Jennifer G. Wilson, MD¹⁹; Alexandra June Gordon, MD¹⁹; Nida Qadir, MD²⁰; Steven Y. Chang, MD, PhD²⁰; Christopher Mallow, MD²¹; Carolina Rivas²¹; Hilary M. Babcock, MD²²; Jennie H. Kwon, DO²²; Matthew C. Exline, MD²³; Natasha Halasa, MD²; James D. Chappell, MD, PhD²; Adam S. Luring, MD, PhD²⁴; Carlos G. Grijalva, MD²; Todd W. Rice, MD²; Ian D. Jones, MD²; William B. Stubblefield, MD²; Adrienne Baughman²; Kelsey N. Womack, PhD²; Christopher J. Lindsell, PhD²; Kimberly W. Hart, MA²; Yuwei Zhu, MD²; Meagan Stephenson, MPH¹; Stephanie J. Schrag, DPH¹; Miwako Kobayashi, MD¹; Jennifer R. Verani, MD¹; Manish M. Patel, MD¹; IVY Network Investigators ([View author affiliations](#))

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Summary

What is already known about this topic?

COVID-19 mRNA vaccines provide strong protection against severe COVID-19; however, the duration of protection is uncertain.

What is added by this report?

Among 1,129 patients who received 2 doses of a mRNA vaccine, no decline in vaccine effectiveness against COVID-19 hospitalization was observed over 24 weeks. Vaccine effectiveness was 86% 2–12 weeks after vaccination and 84% at 13–24 weeks. Vaccine effectiveness was sustained among groups at risk for severe COVID-19.

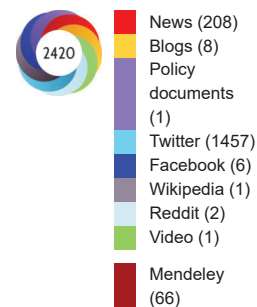
What are the implications for public health practice?

mRNA vaccine effectiveness against COVID-19–associated hospitalizations was sustained over 24 weeks; ongoing monitoring is needed as new SARS-CoV-2 variants emerge. To reduce hospitalization, all eligible persons should be offered COVID-19 vaccination.

Real-world evaluations have demonstrated high effectiveness of vaccines against COVID-19–associated hospitalizations (1–4) measured shortly after vaccination; longer follow-up is needed to assess durability of protection. In an evaluation at 21 hospitals in 18 states, the duration of mRNA vaccine (Pfizer-BioNTech or Moderna) effectiveness (VE) against COVID-19–associated hospitalizations was assessed among adults aged ≥18 years. Among 3,089 hospitalized adults (including 1,194 COVID-19 case-patients and 1,895 non-COVID-19 control-patients), the median age was 59 years, 48.7% were female, and 21.1% had an immunocompromising condition. Overall, 141 (11.8%) case-patients and 988 (52.1%) controls were fully vaccinated (defined as receipt of the second dose of Pfizer-BioNTech or Moderna mRNA COVID-19 vaccines ≥14 days before illness onset), with a median interval of 65 days (range = 14–166 days) after receipt of second dose. VE against COVID-19–associated hospitalization during the full surveillance period was 86% (95% confidence interval [CI] = 82%–88%) overall and 90% (95% CI = 87%–92%) among adults without immunocompromising conditions. VE against COVID-19–associated hospitalization was 86% (95% CI = 82%–90%) 2–12 weeks and 84% (95% CI = 77%–90%) 13–24 weeks from receipt of the

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second vaccine dose, with no significant change between these periods ($p = 0.854$). Whole genome sequencing of 454 case-patient specimens found that 242 (53.3%) belonged to the B.1.1.7 (Alpha) lineage and 74 (16.3%) to the B.1.617.2 (Delta) lineage. Effectiveness of mRNA vaccines against COVID-19–associated hospitalization was sustained over a 24-week period, including among groups at higher risk for severe COVID-19; ongoing monitoring is needed as new SARS-CoV-2 variants emerge. To reduce their risk for hospitalization, all eligible persons should be offered COVID-19 vaccination.

PDF [413K]

Evaluations of authorized mRNA COVID-19 vaccines (Pfizer-BioNTech and Moderna) have consistently demonstrated high VE across diverse populations (1,5). Because COVID-19 vaccines were initially authorized in the United States in December 2020, evaluations of real-world effectiveness have been subject to a short period of postvaccination follow-up. Monitoring durability of protection after COVID-19 vaccination can help determine whether booster vaccines might be indicated, particularly with continued emergence of new variants that might overcome vaccine-induced immunity. In real-world settings, durability of protection has commonly been measured by comparing the odds of vaccination in laboratory-confirmed case-patients and control-patients who tested negative for infection, by time since vaccination (6,7).

During March 11–July 14, 2021, adults aged ≥ 18 years admitted to 21 hospitals in 18 states were included in an analysis of durability of vaccine-induced protection. Case-patients had COVID-19–like illness[†] and had received a positive SARS-CoV-2 reverse transcription–polymerase chain reaction (RT-PCR) or antigen test result. A first group of hospital-based control-patients had COVID-19–like illness and had negative SARS-CoV-2 results by all tests, including at least one RT-PCR test. A second hospital-based control group of patients without COVID-19–like illness (and therefore unlikely to be hospitalized for COVID-19–like illness) was also enrolled (4). This second control group also received negative SARS-CoV-2 results by all tests, including at least one RT-PCR test. Eligibility for enrollment as a case-patient or one of these controls required SARS-CoV-2 testing within 10 days of symptom onset and hospital admission within 14 days of symptom onset. Final case/control status was determined using clinical testing results and central laboratory RT-PCR testing of upper respiratory specimens (nasal swabs or saliva) performed at a central laboratory (Vanderbilt University Medical Center, Nashville, Tennessee) (4). Specimens positive for SARS-CoV-2 with cycle threshold values <32 were sent to University of Michigan (Ann Arbor, Michigan) for whole genome sequencing and SARS-CoV-2 lineage determination (4).

Patients or their proxies were interviewed about baseline demographic characteristics, clinical history (including COVID-19–like signs or symptoms experienced and date of illness onset), and history of COVID-19 vaccination. Vaccine was considered to have been administered if vaccination dates and product names were verified through medical records, state immunization registries, vaccination record cards, or provider or pharmacy records, or if plausibly reported by patient or proxy with date and location of vaccination. A patient was considered to be fully vaccinated if both doses of an authorized mRNA COVID-19 vaccine were administered, with the second dose received ≥ 14 days before illness onset.[§] Participants were excluded from this analysis if they received only 1 dose of an mRNA COVID-19 vaccine, received 2 doses with the second dose <14 days before illness onset, received a non-mRNA COVID-19 vaccine, or received mixed products of an mRNA COVID-19 vaccine (i.e., a different product for each dose).

Vaccine effectiveness against COVID-19–associated hospitalization was estimated using logistic regression, comparing the odds of being fully vaccinated versus unvaccinated between case-patients and controls (including both control groups) using the equation $VE = 100 \times (1 - \text{odds ratio})$ (1). VE over the full surveillance period was assessed, as well as among those with illness onset during March–May and June–July 2021, because of increased circulation of Delta variants in the United States during the latter period (8). Models were adjusted for potential confounders, including admission date (biweekly intervals), U.S. Department of Health and Human Services region, age, sex, and race/ethnicity. Time-varying VE models were then constructed. First, a binary model was constructed by adding a categorical term (2–12 weeks versus 13–24 weeks) for interval from receipt of the second vaccine dose (among vaccinated participants) and illness onset. Unvaccinated patients were assigned values of zero days since vaccination. In additional analyses, other specifications of time were considered, including using linear and natural cubic spline terms. Bootstrapping with 1,000 replications was used to estimate 95% CIs. Subgroup analyses included adults aged ≥ 65 years, patients with immunocompromising conditions,[¶] and patients with three or more categories of chronic medical conditions. A sensitivity analysis was also performed including each of the two control groups in models rather than combining them. Significance of association between VE and time since vaccination was assessed using a likelihood-ratio chi-square test with p -values <0.05 considered statistically significant. Analyses were conducted using R statistical software (version 4.0.3; R Foundation). This activity was determined to be public health surveillance by each participating site and CDC and was conducted consistent with applicable federal law and CDC policy.**

After excluding 722 ineligible patients (461 who were not fully vaccinated or unvaccinated, 127 who received a non-mRNA COVID-19 vaccine or mixed vaccines, and 134 who did not meet other inclusion criteria), 3,089 patients were included in the final analysis (1,194 case-patients and 1,895 in the combined control groups) (Table). The median patient age was 59 years

(interquartile range = 46–69 years), 48.7% were female, 56.7% were non-Hispanic White, and 21.1% had an immunocompromising condition. Among case-patients, 141 (11.8%) were fully vaccinated as were 988 (52.1%) controls. Among 454 case-patient specimens with SARS-CoV-2 lineage determined, 242 (53.3%) were identified as Alpha and 74 (16.3%) as Delta (Figure 1). Delta variants became the dominant virus in mid-June. Overall VE against hospitalization for COVID-19 was 86% (95% CI = 82%–88%) over the full surveillance period, including 90% (95% CI = 87%–92%) among patients without immunocompromising conditions and 63% (95% CI = 44%–76%) among patients with immunocompromising conditions. VE among patients with illness onset during March–May was 87% (95% CI = 83%–90%), and among those with illness onset during June–July was 84% (95% CI = 79%–89%). In models considering time since vaccination, VE was 86% (95% CI = 82%–90%) during the 2–12 weeks after the second vaccine dose and 84% (95% CI = 77%–90%) 13–24 weeks after the second dose; there was no significant difference in VE between these two periods ($p = 0.854$). Models treating time since vaccination as linear and as a natural cubic spline with a knot at the median and boundary knots at the 10th and 90th percentiles also showed no significant change in VE over a 24-week period (linear $p = 0.400$, spline $p = 0.234$) (Supplementary Figure, <https://stacks.cdc.gov/view/cdc/108758>). No significant change in VE over a 24-week period was observed within subgroups (all $p > 0.05$) (Figure 2). In sensitivity analyses, results were similar using individual control groups and combined controls.

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Discussion

In a multistate network that enrolled adults hospitalized during March–July 2021, effectiveness of 2 doses of mRNA vaccine against COVID-19–associated hospitalization was sustained over a follow-up period of 24 weeks (approximately 6 months). These findings of sustained VE were consistent among subgroups at highest risk for severe outcomes from COVID-19, including older adults, adults with three or more chronic medical conditions, and those with immunocompromising conditions. Overall VE in adults with immunocompromising conditions was lower than that in those without immunocompromising conditions but was sustained over time in both populations.

These data provide evidence for sustained high protection from severe COVID-19 requiring hospitalization for up to 24 weeks among fully vaccinated adults, which is consistent with data demonstrating mRNA COVID-19 vaccines have the capacity to induce durable immunity, particularly in limiting the severity of disease (9,10). Alpha variants were the predominant viruses sequenced, although Delta variants became dominant starting in mid-June, consistent with national surveillance data (8). Because of limited sequenced virus, Delta-specific VE was not assessed. VE was similar during June–July when circulation of Delta increased in the United States compared with VE during March–May when Alpha variants predominated, although further surveillance is needed.

The findings in this report are subject to at least six limitations. First, the follow-up period was limited to approximately 24 weeks since receipt of full vaccination because of the recent authorization of mRNA COVID-19 vaccines in the United States. Additional analyses with longer duration of follow-up since vaccination are warranted. Second, effectiveness over time from authorized non-mRNA COVID-19 vaccines, including Janssen's (Johnson & Johnson) vaccine product, was not assessed because of limited use of this vaccine during the surveillance period. Third, time-varying VE was not assessed by lineage because of sample size. Fourth, residual confounding might have been present, although the analysis adjusted for potential confounders, including calendar time and patient age. Fifth, this analysis did not consider VE over time among persons aged <18 years or partially vaccinated persons. Finally, the current analysis only included hospitalized adults and did not include persons with asymptomatic SARS-CoV-2 infection or COVID-19 who did not require hospitalization.

Protection against severe COVID-19 resulting in hospitalization was sustained through 24 weeks after vaccination with mRNA COVID-19 vaccines. To reduce their risk for hospitalization, all eligible persons should be offered COVID-19 vaccination. Continued monitoring of VE against infection and severe disease is needed as the elapsed time since vaccination increases and new SARS-CoV-2 variants emerge.

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IVY Network

Nicole Calhoun, Baylor Scott & White Health; Kempapura Murthy, Baylor Scott & White Health; Judy Herrick, Baylor Scott & White Health; Amanda McKillop, Baylor Scott & White Health; Eric Hoffman, Baylor Scott & White Health; Martha Zayed, Baylor Scott & White Health; Michael Smith, Baylor Scott & White Health; Natalie Settele, Baylor Scott & White Health; Jason Ettlinger, Baylor Scott & White Health; Elisa Priest, Baylor Scott & White Health; Jennifer Thomas, Baylor Scott & White Health; Alejandro Arroliga, Baylor Scott & White Health; Madhava Beeram, Baylor Scott & White Health; Ryan Kindle, Baystate Medical Center; Lori-Ann Kozikowski, Baystate Medical Center; Lesley De Souza, Baystate Medical Center; Scott Ouellette, Baystate Medical Center; Sherell Thornton-Thompson, Baystate Medical Center; Patrick Tyler, Beth Israel Deaconess Medical Center; Omar Mehkri, Cleveland Clinic; Kiran Ashok, Cleveland Clinic; Susan Gole, Cleveland Clinic; Alexander King, Cleveland Clinic; Bryan Poynter, Cleveland Clinic; Nicholas Stanley, Emory University; Audrey Hendrickson, Hennepin County Medical Center; Ellen Maruggi, Hennepin County Medical Center; Tyler Scharber, Hennepin County Medical Center; Jeffrey Jorgensen, Intermountain

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Medical Center; Robert Bowers, Intermountain Medical Center; Jennifer King, Intermountain Medical Center; Valerie Aston, Intermountain Medical Center; Brent Armbruster, Intermountain Medical Center; Richard E. Rothman, Johns Hopkins University; Rahul Nair, Montefiore Medical Center; Jen-Ting (Tina) Chen, Montefiore Medical Center; Sarah Karow, Ohio State University; Emily Robart, Ohio State University; Paulo Nunes Maldonado, Ohio State University; Maryiam Khan, Ohio State University; Preston So, Ohio State University; Joe Levitt, Stanford University; Cynthia Perez, Stanford University; Anita Visweswaran, Stanford University; Jonasel Roque, Stanford University; Adreanne Rivera, University of California, Los Angeles; Trevor Frankel, University of California, Los Angeles; Michelle Howell, UHealth University of Colorado Hospital; Jennifer Friedel, UHealth University of Colorado Hospital; Jennifer Goff, UHealth University of Colorado Hospital; David Huynh, UHealth University of Colorado Hospital; Michael Tozier, UHealth University of Colorado Hospital; Conner Driver, UHealth University of Colorado Hospital; Michael Carricato, UHealth University of Colorado Hospital; Alexandra Foster, UHealth University of Colorado Hospital; Paul Nassar, University of Iowa; Lori Stout, University of Iowa; Zita Sibenaller, University of Iowa; Alicia Walter, University of Iowa; Jasmine Mares, University of Iowa; Logan Olson, University of Iowa; Bradley Clinansmith, University of Iowa; Carolina Rivas, University of Miami; Hayley Gershengorn, University of Miami; EJ McSpadden, University of Michigan; Rachel Truscon, University of Michigan; Anne Kaniclides, University of Michigan; Lara Thomas, University of Michigan; Ramsay Bielak, University of Michigan; Weronika Damek Valvano, University of Michigan; Rebecca Fong, University of Michigan; William J. Fitzsimmons, University of Michigan; Christopher Blair, University of Michigan; Andrew L. Valesano, University of Michigan; Julie Gilbert, University of Michigan; Christine D. Crider, University of Washington; Kyle A. Steinbock, University of Washington; Thomas C. Paulson, University of Washington; Layla A. Anderson, University of Washington; Christy Kampe, Vanderbilt University Medical Center; Jakea Johnson, Vanderbilt University Medical Center; Rendie McHenry, Vanderbilt University Medical Center; Marcia Blair, Vanderbilt University Medical Center; Douglas Conway, Vanderbilt University Medical Center; Mary LaRose, Wake Forest University; Leigha Landreth, Wake Forest University; Madeline Hicks, Wake Forest University; Lisa Parks, Wake Forest University; Jahnvi Bongu, Washington University; David McDonald, Washington University; Candice Cass, Washington University; Sondra Seiler, Washington University; David Park, Washington University; Tiffany Hink, Washington University; Meghan Wallace, Washington University; Carey-Ann Burnham, Washington University; Olivia G. Arter, Washington University

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Corresponding author: Mark W. Tenforde, media@cdc.gov.

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¹CDC COVID-19 Response Team; ²Vanderbilt University Medical Center, Nashville, Tennessee; ³University of Colorado School of Medicine, Aurora, Colorado; ⁴University of Iowa, Iowa City, Iowa; ⁵Baylor Scott & White Health, Temple, Texas; ⁶Texas A&M University College of Medicine, Temple, Texas; ⁷Beth Israel Deaconess Medical Center, Boston, Massachusetts; ⁸Wake Forest University Baptist Medical Center, Winston-Salem, North Carolina; ⁹Johns Hopkins Hospital, Baltimore, Maryland; ¹⁰Hennepin County Medical Center, Minneapolis, Minnesota; ¹¹Montefiore Healthcare Center, Albert Einstein College of Medicine, Bronx, New York; ¹²University of Washington School of Medicine, Seattle, Washington; ¹³Baystate Medical Center, Springfield, Massachusetts; ¹⁴Intermountain Medical Center and University of Utah, Salt Lake City, Utah; ¹⁵University of Michigan School of Public Health, Ann Arbor, Michigan; ¹⁶Oregon Health & Science University Hospital, Portland, Oregon; ¹⁷Emory University School of Medicine, Atlanta, Georgia; ¹⁸Cleveland Clinic, Cleveland, Ohio; ¹⁹Stanford University School of Medicine, Palo Alto, California; ²⁰Ronald Reagan-UCLA Medical Center, Los Angeles, California; ²¹University of Miami, Miami, Florida; ²²Washington University, St. Louis, Missouri; ²³Ohio State University Wexner Medical Center, Columbus, Ohio; ²⁴University of Michigan School of Medicine, Ann Arbor, Michigan.

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* These authors contributed equally to this report.

[†] COVID-19–like illness was defined as having one or more of the following: fever, cough, shortness of breath, loss of taste, loss of smell, use of respiratory support for the acute illness, or new pulmonary findings on chest imaging consistent with pneumonia.

[§] The date of illness onset was used for cases and controls with COVID-19–like illness with median value imputed if missing. For controls without COVID-19–like illness, the date of admission minus the median number of days between illness onset and admission for patients with COVID-19 was used for a date of illness onset, also referred to as “illness onset” for this report.

[¶] Immunocompromising conditions included having one or more of the following: active solid organ cancer (active cancer defined as treatment for the cancer or newly diagnosed cancer in the past 6 months), active hematologic cancer (such as leukemia, lymphoma, or myeloma), HIV infection without AIDS, AIDS, congenital immunodeficiency syndrome, previous splenectomy, previous solid organ transplant, immunosuppressive medication, systemic lupus erythematosus, rheumatoid arthritis, psoriasis, scleroderma, or inflammatory bowel disease, including Crohn’s disease or ulcerative colitis.

** 45 C.F.R. part 46.102(l)(2), 21 C.F.R. part 56; 42 U.S.C. Sect 241(d); 5 U.S.C. Sect 552a; 44 U.S.C. Sect 3501 et seq.

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**TABLE. Characteristics of COVID-19 case-patients and controls among hospitalized adults — 21 academic medical centers in 18 states, March–July 2021**

Characteristic	No. (%)			P-value*
	Overall (N = 3,089)	Cases (n = 1,194)	Controls (n = 1,895)	
Median age, yrs (IQR)	59 (46–69)	56 (42–66)	62 (48–71)	<0.001
Age group, yrs				<0.001
18–49	950 (30.8)	445 (37.3)	505 (26.7)	
50–64	1,008 (32.6)	424 (35.5)	584 (30.8)	
≥65	1,131 (36.6)	325 (27.2)	806 (42.5)	
Sex				
Female	1,504 (48.7)	580 (48.6)	924 (48.8)	0.921
Race/Ethnicity				<0.001
White, non-Hispanic	1,752 (56.8)	548 (45.9)	1,204 (63.5)	
Black, non-Hispanic	693 (22.4)	312 (26.1)	381 (20.1)	
Hispanic, any race	467 (15.1)	245 (20.5)	222 (11.7)	
Other, non-Hispanic	140 (4.5)	67 (5.6)	73 (3.9)	
Unknown	37 (1.2)	22 (1.8)	15 (0.8)	
Region†				<0.001
Northeast	432 (14.0)	165 (13.8)	267 (14.1)	
South	1,151 (37.3)	459 (38.4)	692 (36.5)	
Midwest	818 (26.5)	265 (22.2)	553 (29.2)	
West	688 (22.3)	305 (25.5)	383 (20.2)	
Resident in long-term care facility (100 unknown)	141 (4.7)	29 (2.5)	112 (6.1)	<0.001
Previous hospitalization in last year (231 unknown)	1,297 (45.4)	319 (30.0)	978 (54.5)	<0.001
No. of baseline conditions (2 unknown)§				<0.001
0	552 (17.9)	301 (25.2)	251 (13.3)	
1	736 (23.8)	310 (26.0)	426 (22.5)	

Characteristic	No. (%)			P-value*
	Overall (N = 3,089)	Cases (n = 1,194)	Controls (n = 1,895)	
2	766 (24.8)	260 (21.8)	506 (26.7)	
≥3	1,033 (33.5)	322 (27.0)	711 (37.5)	
Specific chronic conditions				
Cardiovascular disease (1 unknown)	1,900 (61.5)	647 (54.2)	1,253 (66.2)	<0.001
Pulmonary disease (1 unknown)	804 (26.0)	257 (21.5)	547 (28.9)	<0.001
Diabetes mellitus (1 unknown)	952 (30.8)	348 (29.2)	604 (31.9)	0.108
Immunocompromising condition*(2 unknown) [§]	652 (21.1)	205 (17.2)	447 (23.6)	<0.001
Fully vaccinated**	1,129 (36.6)	141 (11.8)	988 (52.1)	<0.001
Vaccine product received (among fully vaccinated persons)				0.030
Pfizer-BioNTech	666 (59.0)	95 (67.4)	571 (57.8)	
Moderna	463 (41.0)	46 (32.6)	417 (42.2)	
If fully vaccinated, median (IQR) days from second vaccine dose and onset of symptoms	65 (41–93)	60 (36–94)	66 (42–93)	0.509

Abbreviation: IQR = interquartile range.

* P-values determined using the Wilcoxon rank-sum test for continuous variables and by chi-square test of independence for categorical variables.

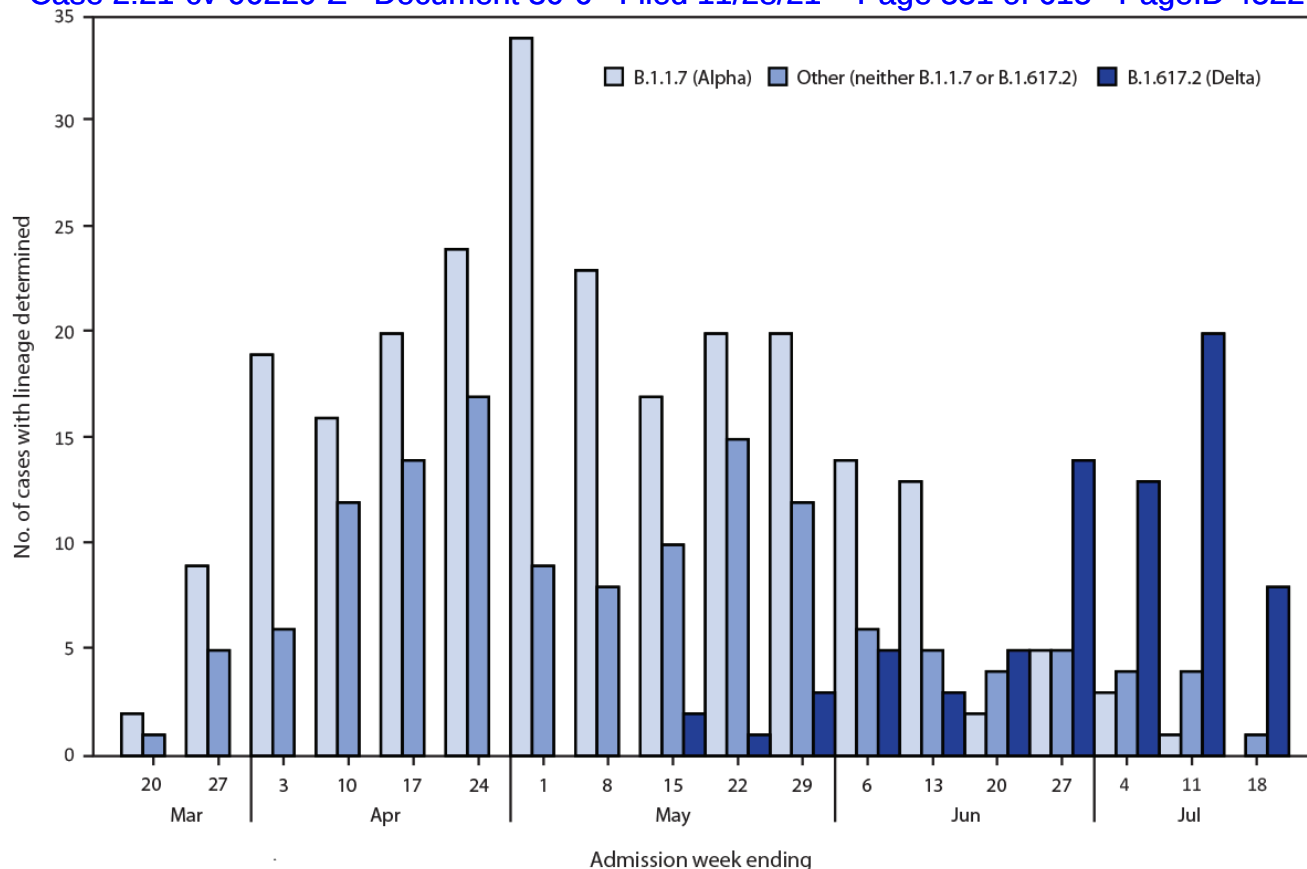
[†] Hospitals by region included *Northeast*: Baystate Medical Center (Springfield, Massachusetts), Beth Israel Deaconess Medical Center (Boston, Massachusetts), Montefiore Medical Center (Bronx, New York); *South*: Vanderbilt University Medical Center (Nashville, Tennessee), University of Miami Medical Center (Miami, Florida), Emory University Medical Center (Atlanta, Georgia), Johns Hopkins Hospital (Baltimore, Maryland), Wake Forest University Baptist Medical Center (Winston-Salem, North Carolina), Baylor Scott and White Health (Temple, Texas); *Midwest*: University of Iowa Hospitals (Iowa City, Iowa), University of Michigan Hospital (Ann Arbor, Michigan), Hennepin County Medical Center (Minneapolis, Minnesota), Barnes-Jewish Hospital (St. Louis, Missouri), Cleveland Clinic (Cleveland, Ohio), Ohio State University Wexner Medical Center (Columbus, Ohio); *West*: Stanford University Medical Center (Stanford, California), UCLA Medical Center (Los Angeles, California), UCHealth University of Colorado Hospital (Aurora, Colorado), Oregon Health & Science University Hospital (Portland, Oregon), Intermountain Medical Center (Murray, Utah), University of Washington (Seattle, Washington).

[§] Chronic condition categories included the following: cardiovascular disease, neurologic disease, pulmonary disease, gastrointestinal disease, endocrine disease, renal disease, hematologic disease, malignancy, immunosuppression not captured in other categories, autoimmune condition, or other condition (sarcoidosis, amyloidosis, or unintentional weight loss ≥10 pounds in the last 90 days).

[¶] Immunocompromising conditions included having one or more of the following: active solid organ cancer (active cancer defined as treatment for the cancer or newly diagnosed cancer in the past 6 months), active hematologic cancer (such as leukemia, lymphoma, or myeloma), HIV infection without AIDS, AIDS, congenital immunodeficiency syndrome, previous splenectomy, previous solid organ transplant, immunosuppressive medication, systemic lupus erythematosus, rheumatoid arthritis, psoriasis, scleroderma, or inflammatory bowel disease, including Crohn's disease or ulcerative colitis.

** COVID-19 vaccination status included unvaccinated, defined as no receipt of any SARS CoV-2 vaccine, and fully vaccinated, defined as receipt of both doses of a 2-dose mRNA vaccine with the second dose received ≥14 days before illness onset.

FIGURE 1. Whole genome sequencing lineage determination among adults hospitalized with COVID-19 — 21 academic medical centers in 18 states,*[†] March–July 2021

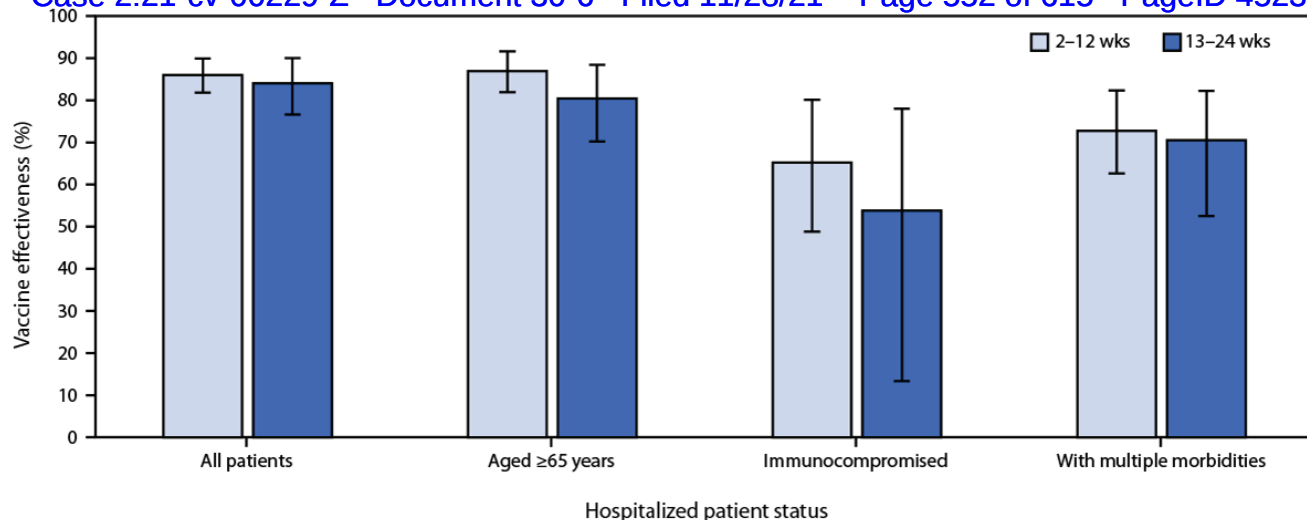


* Specimens with SARS-CoV-2 detected by reverse transcription–polymerase chain reaction and with a cycle threshold <32 for at least one of two nucleocapsid gene targets tested underwent whole genome sequencing. SARS-CoV-2 lineages were assigned with >80% coverage using Pangolin genomes. Results are presented for B.1.1.7 (Alpha) variants, B.1.617.2 (Delta) variants, and other (neither B.1.1.7 or B.1.617.2) variant with lineage determined by whole genome sequencing. Of 74 Delta variants sequenced, four belonged to the AY.3 Delta sublineage. The histogram provides the number of viruses sequenced by week of hospital admission.

† Hospitals by region included *Northeast*: Baystate Medical Center (Springfield, Massachusetts), Beth Israel Deaconess Medical Center (Boston, Massachusetts), Montefiore Medical Center (Bronx, New York); *South*: Vanderbilt University Medical Center (Nashville, Tennessee), University of Miami Medical Center (Miami, Florida), Emory University Medical Center (Atlanta, Georgia), Johns Hopkins Hospital (Baltimore, Maryland), Wake Forest University Baptist Medical Center (Winston-Salem, North Carolina), Baylor Scott and White Health (Temple, Texas); *Midwest*: University of Iowa Hospitals (Iowa City, Iowa), University of Michigan Hospital (Ann Arbor, Michigan), Hennepin County Medical Center (Minneapolis, Minnesota), Barnes-Jewish Hospital (St. Louis, Missouri), Cleveland Clinic (Cleveland, Ohio), Ohio State University Wexner Medical Center (Columbus, Ohio); *West*: Stanford University Medical Center (Stanford, California), UCLA Medical Center (Los Angeles, California), UCHealth University of Colorado Hospital (Aurora, Colorado), Oregon Health & Science University Hospital (Portland, Oregon), Intermountain Medical Center (Murray, Utah), University of Washington (Seattle, Washington).

FIGURE 2. Sustained vaccine effectiveness* against COVID-19 among hospitalized adults, by patient status^{†,§} and interval since vaccination — 21 medical centers in 18 states,[¶] March–July 2021

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Abbreviation: VE = vaccine effectiveness.

* VE was estimated using logistic regression comparing the odds of being fully vaccinated with an authorized mRNA COVID-19 vaccine with being unvaccinated in case patients and controls using the equation $VE = 100 \times (1 - \text{odds ratio})$. Models were adjusted for date of hospital admission (biweekly intervals), U.S. Department of Health and Human Services region of hospital, age group (18–49, 50–64, or ≥65 years), sex, and race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic of any race, non-Hispanic Other, or unknown). Analyses restricted to adults aged ≥65 years adjusted for age in years as a continuous variable. Binary time since second dose of mRNA vaccine was added to the model with results for 2–12 weeks and 13–24 weeks shown. 95% confidence intervals shown by error bars.

† Immunocompromising conditions included having one or more of the following: active solid organ cancer (active cancer defined as treatment for the cancer or newly diagnosed cancer in the past 6 months), active hematologic cancer (such as leukemia, lymphoma, or myeloma), HIV infection without AIDS, AIDS, congenital immunodeficiency syndrome, previous splenectomy, previous solid organ transplant, immunosuppressive medication, systemic lupus erythematosus, rheumatoid arthritis, psoriasis, scleroderma, or inflammatory bowel disease, including Crohn's disease or ulcerative colitis.

§ Multiple morbidities were defined as having chronic conditions within three or more of the following condition categories: cardiovascular disease, neurologic disease, pulmonary disease, gastrointestinal disease, endocrine disease, renal disease, hematologic disease, malignancy, immunosuppression not captured in other categories, autoimmune condition, or other condition (sarcoidosis, amyloidosis, or unintentional weight loss ≥10 pounds in the last 90 days).

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The Case for Mandating COVID-19 Vaccines for Health Care Workers

Michael Klompas, MD, MPH; Madelyn Pearson, DNP, RN; and Charles Morris, MD, MPH

Almost 15 years have passed since hospitals first began mandating influenza vaccines for health care workers. This initially innovative but now common policy was prompted by a dual desire to protect patients from health care-acquired influenza and to protect the workplace from the disruption and expense of worker illnesses. Health care organizations are now wrestling with whether to mandate SARS-CoV-2 vaccination for all employees. We believe that the case for mandating SARS-CoV-2 vaccines for health care workers is substantially stronger than the case was for mandating influenza vaccines (Table).

THE MORBIDITY AND MORTALITY OF COVID-19 FAR EXCEEDS THAT OF INFLUENZA

The mortality rate for influenza is estimated to be 1 in 1000, whereas that for SARS-CoV-2 is closer to 1 in 100 to 250 (1). Patients with COVID-19 are more likely to require hospital admission, have respiratory failure, and require prolonged intensive care than those with influenza (2). In 2020 alone, SARS-CoV-2 is estimated to have caused more than 522 000 excess deaths in the United States (3). Post-COVID-19 symptoms also seem to be more common, more pronounced, and more long-lasting than those after influenza.

SARS-CoV-2 THREATENS ESSENTIAL WORKERS' LIVES

Vaccines for SARS-CoV-2 save lives (4). Health care workers and other essential workers have higher rates of infection than people in other fields (5). According to the Centers for Disease Control and Prevention, more than 1600 U.S. health care workers have died of COVID-19 thus far. Although it is unclear how many of these infections were acquired in the workplace versus the community, vaccine mandates will prevent infections, severe illness, and deaths in health care workers no matter where they are exposed.

NOSOCOMIAL TRANSMISSION OF SARS-CoV-2 IS COMMON

Up to two thirds of cases of SARS-CoV-2 infection are attributable to asymptomatic and presymptomatic transmissions. Hospitals have undertaken considerable efforts to stop staff from working while sick, but these policies do not prevent staff with silent infections from coming to work and potentially infecting patients and colleagues. In some cases, staff-to-patient and staff-to-staff transmissions have led to large clusters (6). Universal masking diminishes this risk, but perfect adherence is not realistic and surgical masks are not perfectly protective; nosocomial transmission despite masks has been well documented (7). Vaccines, by contrast, provide constant protection

without requiring reminders, persuasion, mask-fitting aids, or behavioral changes.

SARS-CoV-2 VACCINATION FOR HEALTH CARE WORKERS IS HEALTH CARE DELIVERY

We believe that there is an extra onus on health care workers to protect themselves from SARS-CoV-2 in order to protect patients. Health care workers routinely tend to the elderly, ill, and vulnerable, in whom SARS-CoV-2 infection is more likely to be deadly. We cannot rely on patients being vaccinated to prevent nosocomial transmission because some patients cannot get the vaccine, some will decline, and vaccine may not be effective in immunocompromised patients (8). Vaccinating health care workers, however, helps protect even unvaccinated patients because SARS-CoV-2 vaccines are associated with fewer infections overall, less silent carriage, and less risk for transmission (4, 9).

COVID-19 VACCINES ARE MORE EFFECTIVE THAN INFLUENZA VACCINES

The estimated effectiveness of influenza vaccines varies by season but generally ranges from 30% to 50%. The 2 messenger RNA vaccines for SARS-CoV-2, by contrast, are more than 90% effective. Notwithstanding the moderate effectiveness of influenza vaccines, randomized trials suggest that vaccinating health care workers in congregate health care settings may decrease patient deaths by 30% (10). The life-saving effects of vaccinating health care workers against COVID-19 will be that much greater given these vaccines' greater effectiveness against a pathogen that is more common and more deadly than influenza.

SARS-CoV-2 IS MORE DISRUPTIVE TO HOSPITAL OPERATIONS THAN INFLUENZA

The SARS-CoV-2 pandemic has had an unprecedented effect on day-to-day operations in health care. Changes include universal masking, daily attestations of health, limitations on visitors, cancellations of surgery and elective admissions, cancellation of in-person meetings and education sessions, cancellation of travel, and much more. Universal vaccination is the pathway to rolling back these disruptions and returning to normal operations.

SARS-CoV-2 IS MORE DISRUPTIVE TO WORKFORCE CONTINUITY THAN INFLUENZA

Vaccinating health care workers will help preserve workforce continuity. Workers with influenza are typically allowed to return to work 24 hours after their fever

Table. The Case for Mandating COVID-19 Vaccines for Health Care Workers: Comparison of Influenza Versus COVID-19

Effect	Influenza	COVID-19
Mortality	~1 in 1000	~4-10 in 1000
Number of people infected	Infects ~10% of the U.S. population each year	Infected ~30% of the U.S. population in 2020
Threat to patients	Nosocomial spread well documented but understudied	Nosocomial spread well documented but understudied
Impact on operations	Absorbed by routine operations	Unprecedented disruption of routine operations (e.g., masking, distancing, virtual meetings, visitor restrictions, testing requirements, attestations)
Time lost to work	Employees return to work 1 d after fever resolves	Mandatory absence of at least 10 d
Vaccine effectiveness	30%-50%	70% for adenovirus vector; 90%-95% for mRNA
Vaccine experience	~50% of adults get influenza vaccine each year	>65% of U.S. adults vaccinated thus far

mRNA = messenger RNA.

subsidies. Staff with SARS-CoV-2 infection, however, are required to isolate for at least 10 days, even if their symptoms resolve well before then. Staff shortages have pushed some hospitals to cancel procedures, close units, and reduce elective admissions, thereby putting patients at risk due to deferred care. Vaccines will help keep more staff healthy and at work.

SARS-CoV-2 VACCINES ARE SAFE

More adults have now been inoculated against SARS-CoV-2 than are typically vaccinated against influenza in a given year. More than 300 million doses of SARS-CoV-2 vaccine have been administered in the United States alone, and more than 65% of U.S. adults have been vaccinated. By contrast, in a typical influenza season only about 150 million to 175 million doses of influenza vaccine are administered and fewer than 50% of adults are immunized. Despite the enormous number of people who have now received SARS-CoV-2 vaccines, serious side effects have been exceedingly rare. We acknowledge that some life-threatening adverse effects and deaths have occurred, but the incidence of these complications is vanishingly small, is substantially lower than the risk for complications of COVID-19, and is far outweighed in our opinion by the likelihood of benefit to both health care workers and their patients. Similarly, we believe that these benefits also outweigh the other possible reasons that health care workers may object to vaccination, including fear of postvaccine side effects, concerns about fetal safety, philosophical disagreement, and perceived invulnerability to serious infection.

Many organizations contemplating mandating SARS-CoV-2 vaccines are reluctant to move forward while vaccines remain under emergency use authorization. Some are also concerned about legal challenges. As more safety data on the vaccines rapidly accumulate, however, there is every expectation of full approval from the U.S. Food and Drug Administration later this year, and the courts have ruled in favor of health care organizations on the legal challenges that have come forward thus far. Now is the time for organizations to ready themselves to adopt mandatory vaccination policies as soon as full approval is granted. This includes drafting policies, educating employees about vaccine safety and effectiveness, developing strategies to address unvaccinated employees' specific concerns, ensuring easy vaccine access,

partnering with employee leaders and unions to make a shared case for universal vaccination, weighing potential exemptions, and foreshadowing the road ahead for all.

From Harvard Medical School, Harvard Pilgrim Health Care Institute, and Brigham and Women's Hospital, Boston, Massachusetts (M.K.); and Brigham and Women's Hospital, Boston, Massachusetts (M.P., C.M.).

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Corresponding Author: Michael Klompas, MD, MPH, Department of Population Medicine, 401 Park Drive, Suite 401 East, Boston, MA 02215; e-mail, mklompas@bwh.harvard.edu.

Current author addresses and author contributions are available at Annals.org.

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Current Author Addresses: Dr. Klompas: Department of Population Medicine, 401 Park Drive, Suite 401 East, Boston, MA 02215.
Drs. Pearson and Morris: Brigham and Women's Hospital, 75 Francis Street, Boston, MA 02115.

Author Contributions: Conception and design: M. Klompas, C. Morris.
Drafting of the article: M. Klompas, M. Pearson, C. Morris.
Critical revision of the article for important intellectual content: M. Klompas, C. Morris.
Final approval of the article: M. Klompas, M. Pearson, C. Morris.



A Better Jobs Better Care Practice & Policy Report

The Cost of Frontline Turnover in Long-Term Care

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**THE COST OF FRONTLINE TURNOVER
IN LONG-TERM CARE**

**by
Dorie Seavey**

October 2004

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About the author:

Dorie Seavey is a labor economist who works for PHI in New York. Her areas of expertise include labor issues for low-wage workers and workforce development for front-line health and social service workers. She served as a senior member of an evaluation team at Public/Private Ventures investigating the four-year Sectoral Employment Initiative of the Charles Stuart Mott Foundation. Seavey is a former Senior Research Scientist at the Heller School of Social Policy at Brandeis University. She holds a Ph.D. in Economics from Yale University.

THE COST OF FRONTLINE TURNOVER IN LONG-TERM CARE

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The Cost of Frontline Turnover in Long-Term Care

EXECUTIVE SUMMARY

Across the country, the high rate of turnover among frontline workers in long-term care is a serious workforce problem. Concern about high turnover rates has led to numerous initiatives to improve recruitment and retention of this critical workforce. Much less well explored have been the costs of turnover—their magnitude, their bottom line impact on provider finances, and their effect on the quality of the services provided to long-term care clients and consumers.

This report details what is known about turnover costs among the direct care workforce, presents a framework for measuring them, and explains why they are important to track. Turnover among frontline workers is a critical cost driver for the long-term care industry, affecting the fiscal health of providers, the quality of care that long-term care consumers receive, and the efficiency of resource allocation within the public payer system. The potential magnitude of these costs, and the fact that key elements of the total cost of turnover are not visible or easily measured, lead to important implications for practice and policy, and for future research.

Evidence on Direct-Care Turnover Costs

To date, only a handful of detailed studies have been conducted that attempt to quantify the per worker costs of frontline turnover in different long-term care settings—nursing home care, home care, and community-based care facilities for individuals with intellectual or developmental disabilities (ID/DD). All of these studies pertain to one or more providers or facilities located in one state only, and most concern ID/DD settings. A review of the literature indicates that:

- turnover costs at the enterprise or organizational level are best estimated by using an expanded accounting model that includes both direct and indirect costs;
- the *indirect* costs of turnover may be substantial and tend to be overlooked because they are less visible and harder to measure; and
- the *direct cost* of turnover per frontline worker is at least \$2,500, based on a conservative working estimate.

Accounting for Turnover Costs among Direct Care Workers

Empirical studies on the cost of turnover for direct-care workers and low-wage service workers generally use an accounting framework for costing turnover per worker at the **enterprise level**. This approach usually distinguishes between several categories of direct and indirect costs, and identifies turnover-related productivity losses as an important but often neglected cost category.

While the enterprise or organizational level tends to be the main focus of turnover cost analysis, significant costs are also incurred at two other levels. First, costs are incurred at the **service delivery level** by consumers who may receive lower quality of care from inexperienced workers, and by frontline workers who may be subject to greater stress and risk of injury. Second, costs are incurred at the **third-party payer level** by public funders and private insurers, who play major roles in designing, managing, and financing long-term care services.

Understanding these two additional layers of costs is critical to calculating the full cost burden of frontline turnover and leads to a wider set of practice and policy implications. For example, because turnover costs at the service delivery and payer levels are not integrated into providers' cost structures, providers may not find it cost-effective to make the investments needed to reduce turnover. But by not making those investments, substantial "downstream" turnover costs may be incurred by the other stakeholders — consumers and their families, workers, and third-party payers.

Implications for Practice, Policy and Research

Practice/Provider Implications

Overall turnover costs borne by long-term care providers appear to be substantial and can constitute a significant financial drain on a provider's bottom line. Far from being an inevitable cost of doing business, providers can measure and track turnover costs, make informed decisions about how much they can afford to invest in keeping or retaining employees, and assess whether or not such investments are improving their bottom line. The strict financial case for reducing turnover will be sensitive each provider's costs and organizational infrastructure. However, all providers can reduce turnover costs by: 1) knowing the true cost of turnover; 2) calculating turnover rates carefully; and, 3) investing in proven retention strategies.

Policy Implications

High turnover costs have serious financial impacts on federal, state and local governments, which together foot most of the bill for long-term care. The costs of turnover to the public sector are tantamount to an implicit tax on reimbursement rates paid to publicly-financed providers -- a hidden tax which ultimately is paid by taxpayers for high industry turnover costs. While the exact costs are difficult to measure, the evidence suggests that the price paid by government payers for turnover in long-term care is on the order of roughly \$2.5 billion. This figure does not include the costs of increased health care costs due to lower care quality for consumers or higher injury-related medical costs for workers.

Public policy can play an important role in creating better feedback mechanisms so that significant costs borne in one part of the system (e.g., increased medical costs due to turnover-related lower quality care) become more visible and are taken into account by other stakeholders in the long-term care system. Policymakers themselves would benefit from research comparing which public policies and which provider practices have the greatest impact on stabilizing the direct-care workforce. This would help in the development of rate adjustments or incentives for provider investments that result in lower turnover rates.

Research Implications

Field work and research are needed in several areas. Further improvements and refinements are needed in both the statistical and fiscal measures used to measure turnover costs, along with applications of these measures in the field to document actual turnover costs. It would also be useful to develop methods at both the state and national level to monitor turnover costs across the spectrum of long-term care settings.

To better calculate the indirect costs paid by consumers and payers, research is also needed on the links between turnover and care quality and how care outcomes differ between high and low turnover environments. Lastly, further investigation is needed to understand the sensitivity of turnover rates to different variables, such as improved compensation and other retention strategies, as well as which factors differentiate low and high turnover organizations.

THE COST OF FRONTLINE TURNOVER IN LONG-TERM CARE

I. Introduction

Across the country, turnover among frontline workers in long-term care¹ has been identified as a serious workforce problem, and concern about elevated turnover rates² has led to considerable focus on understanding the challenges associated with recruitment and retention of this critical workforce. Much less well explored have been the costs of turnover—their magnitude, their “bottom line” impact on provider finances, and their effect on the quality of the services provided to long-term care clients and consumers.

Not all turnover is “bad” and in every enterprise, some turnover is inevitable. However, in a highly labor-intensive, service industry such as long-term care where turnover rates are known to be elevated, these costs can be problematic. Each time a direct care worker leaves a long-term care provider organization, financial and human resources are lost to new recruitment and training, and either overtime is paid out to an often increasingly stressed workforce, expensive replacements are hired in from temporary staffing agencies, or care hours simply go undelivered.

In addition, with every quit or termination, the caregiving relationships and services provided to clients—the core commodity of long-term care—at a minimum are disrupted and sometimes are so compromised that the well-being of both clients and workers is negatively affected due, for example, to increased injury rates on both sides. Simply put, frontline turnover in long-term care can be expensive, and when it does become costly, it becomes a business problem, a quality-of-care problem, and a public resource problem.

This paper addresses what is known about the costs of turnover in long-term care, summarizing existing evidence on the overall size of these costs as well as related evidence on the costs of turnover in low-wage jobs generally in the U.S. economy. Based on the literature in this field, the paper proposes a framework for identifying the costs of frontline turnover, delineating the different elements that ideally should be tracked in order to arrive at reliable cost estimates. The paper concludes with implications for three areas: provider practice, national and state policy, and further research.

II. Evidence on Direct-Care Turnover Costs

To date, only a handful of detailed studies have been conducted that attempt to quantify the per worker costs of frontline turnover in long-term care. The basic findings of these studies are presented in Table 1. Several different direct-care settings are covered by the studies—nursing home care, home care, and community-based care organizations—but the majority of studies pertain to settings that serve individuals with intellectual or developmental disabilities (ID/DD). One turnover cost study that treated allied health personnel as an occupational grouping is also included because of its pertinence to health care settings generally and its methodological features (Waldman et al., 2004, who

defined allied health personnel to include several categories of direct-care workers but also different kinds of technicians). All of the studies pertain to one or more providers or facilities located in one state only; turnover rates in these sites ranged from 40% to 166%.

Table 1: Studies Examining Costs of Turnover for Direct Care Workers

Study	Key Findings
Zahrt 1992	Careful documentation of the costs of replacing home care worker in a single certified public home care agency in the Midwest determined a total cost associated with each instance of turnover \$3,362. The calculations included: recruitment costs of \$398 (advertising, outreach, printing brochures, interviewing time, and time to check references); orientation expenses of \$675 (staff, materials, and travel); training expenses of \$1,859 (certification training, practicum, and competency evaluation); ³ and termination costs of \$431 (exit interview and evaluation time, paperwork processing, accrued vacation/holiday leave, and substitute aide salary and benefits). The author notes that her calculations do not account for lost services to clients and lost revenue from funding sources.
Johnston 1998	This study surveyed all developmental disability service providers in Alaska that contract with the state (28 in total of which 23 responded). Providers were asked how much they spent on advertising, overtime due to shift vacancies, and other recruitment costs (e.g., fingerprinting, administration time, Hepatitis B vaccinations), orientation training, and other necessary training (e.g., First Aid, CPR, & Mandt training). The average statewide cost of turnover per worker was \$2,341.
Fullager et al. 1998	This study collected financial data on the costs of turnover from all 28 Kansas Community Developmental Disability Organizations. The average cost of turnover was \$2,094 with training costs constituting nearly two-thirds of the total estimated cost. The costs of separation and replacement were also measured.
Straker & Atchley 1999	Interviews were conducted with a representative sample of 112 nursing homes and 100 certified home health agencies in Ohio focusing on employers' recruitment and retention practices. Only 17% of the sample had ever calculated the cost of turnover in their organization. Self-reported costs showed significant differences across the two types of organizations, and, in the authors' view, underestimated true turnover costs because the typical provider only included a few of the possible cost elements in their calculations. Of those organizations which had examined their turnover costs, their self-reported estimates of total turnover cost per employee ranged from \$1,885 to \$2,100 for nursing homes and \$951 to \$1,242 for home health agencies.

Seninger & Traci 2002	Cost data were collected from 7 Montana developmental disabilities service providers, including information on the costs of separation, new hires, training, and vacancy (overtime) pay. The indirect costs of lost productivity were not measured. Average turnover costs were estimated to be \$2,627.
Larson 2004	Cost per turnover among direct support professionals in Minnesota was estimated at \$2,592. Cost elements included the costs of leaving, hiring, and training. The study also noted known costs not included in its estimates such as exit interview processing, separation pay, lost client revenues, physical exams, and hiring bonuses.
Vinfen Corporation 2004	Cost per replacement hire for 2004 was estimated at \$5,276 for a large, non-profit human services organization in Massachusetts that provides programs and services to help people with disabilities. The agency employs nearly 2,000 direct care workers. Cost elements included: overtime associated with replacement of terminated employees and shift coverage while new hire is in training (\$1,498); non-productive training time (\$999); human resources department staff time devoted to recruiting and training replacement staff (\$1,948); and recruiting advertising (\$831).
Waldman et al. 2004	This study estimated turnover costs for several occupational groupings at a major academic medical facility in the Southwest and is notable for the methodology it uses to estimate the cost of reduced productivity. Allied health personnel (which includes some direct care workers) ⁴ had average costs of hiring and training of \$2,307. Lost productivity added an additional \$4,061 to \$10,709 to the cost of turnover, yielding an estimate of total average turnover costs of at least \$6,368. Across all categories of jobs ranging from doctors to support personnel, the study found that the hidden costs of reduced productivity far outweighed the more easily measured direct costs associated with hiring and training.

Before analyzing what these studies tell us about the cost of frontline turnover in long-term care, the next part considers two other perspectives: rule-of-thumb estimates of turnover costs applied to direct care, and evidence on the costs of turnover in low-wage service work generally.

“Rule-of-Thumb” Estimates of Direct-Care Turnover Costs

The most commonly used, conservative rule-of-thumb for estimating the per worker cost of turnover in the overall U.S. economy puts the comprehensive cost of replacing a lost employee at 25% of his or her annual compensation amount. Applying this rule, the Employment Policy Foundation (December 2002) calculates that “[f]or the typical full-time employee who earns \$38,481 and receives \$50,025 in total compensation, the total cost of turnover would amount to \$12,506 per employee.” The 25% rule-of-thumb applied to US Bureau of Labor Statistics estimates of the annual wages of direct-care workers suggests a total cost of turnover per employee in the range of \$4,200 to \$5,200.⁵

Evidence on the Cost of Turnover in Low-Wage Service Work Generally

While their numbers are not large, studies of turnover costs in low-wage service jobs provide an interesting reference point to the extant empirical work on estimating the costs of turnover of direct-care workers. Not surprisingly, studies using a narrower definition of turnover costs tend to find lower costs than those which extend the definition to include the cost of performance differentials between the “leaving” employee and replacement employee. A recent study of hotel, retail, and restaurant employees in Santa Monica, CA found direct turnover costs (i.e., the costs of separation, recruitment and training) of \$2,090 for non-managerial workers earning an average hourly wage of \$7.58 (Pollin and Brenner, 2000). A study of hotel employees in Miami and New York City, which in addition to direct costs also accounted for the cost of lost productivity and peer and supervisor disruption, found turnover costs in Miami ranging from \$1,332 for room-service wait staff, to \$2,077 for line cooks, to \$3,383 for gift-shop clerks, and to \$5,688 for front-office associates (Hinkin and Tracey, 2000). The researchers’ estimates for comparable positions in New York hotels were approximately twice those found in Miami.⁶

Constituting over half of the total cost of turnover for each occupation in this study,⁷ Hinkin and Tracey comment that the costs of lost productivity are “hidden ‘soft’ costs which are almost never formally accounted for and consist primarily of inefficiency while the employee is learning the job and disruption of others caused by the new employee’s inexperience”.(p. 19)

Another study which also included the costs of lost productivity is an investigation of low-wage workers at San Francisco Airport (Reich, Hall, and Jacobs, 2003). The cost of turnover was estimated to be in the range of \$2,430 to \$4,840 per worker, where the cost categories included training, non-training costs, and the costs of lost productivity. Finally, a study of supermarket employees for the Coca-Cola Retailing Research Council (2000) found turnover costs for supermarket cashiers earning \$6.50 an hour of \$3,637. Costs were defined to include “direct costs” (advertising, training, interviewing, testing, new employee orientation) as well as “opportunity costs” (change-making errors, paperwork mistakes, damaging products, inventory shrinkage, and improper use of equipment).⁸

Implications of Research Findings

Drawing on both its limitations and strengths, the existing literature on turnover costs in long-term care and low-wage service work suggests some important considerations and emerging findings:

1. Turnover costs at the enterprise or organizational level are best estimated by using an expanded accounting model that includes both direct and indirect cost categories. Direct costs to providers include the costs of recruiting and training replacements as well as the costs of separation and vacancy. It can be argued that the costs of injuries to workers in frontline work also should be treated as a direct cost. Other costs accruing to providers are more difficult to measure and may be experienced more indirectly precisely because they are less visible. The latter include, for example, the costs associated with productivity losses and lowered service quality.

2. Providers' indirect costs of turnover may be substantial. The existing literature advances the notion that the indirect costs relating to reduced productivity may be substantial, and, therefore, that estimates of turnover costs that do not include indirect costs are likely to underestimate the true cost of turnover, perhaps significantly.

3. A minimum *direct cost* of turnover per worker of at least \$2,500 is supported by the existing empirical literature on frontline turnover costs in long-term care as well as low-wage service employment generally. While meaningful and detailed comparisons between turnover studies are possible only when the specific cost elements are specified and similar, all of the studies summarized in Table 1 attempt to account for the most obvious and easily quantifiable cost categories—namely leaving, hiring, and training (basic direct costs). However, for most of the studies, the specific composition of the costs for each of those categories is not known. This being said, all of studies (with the exception of Straker and Atchley [1999] which is based on provider self-reporting), find basic direct turnover costs per employee of at least \$2,500. Similar cost magnitudes for the same categories have been found for low-wage workers in hotel, retail, restaurants, and airport work (see Table 2).

The conservative rule-of-thumb turnover rule applied to direct-care workers yields a cost reference point that is essentially double the basic turnover costs found by researchers to date. This comparison, along with the suggestion of several studies that there are important indirect costs to turnover that are more difficult to measure, suggest that greater attention should be given to measuring indirect costs, and that direct costs on the order of \$2,500 per incidence of turnover are a conservative minimum.

III. A Framework for Costing Turnover in Direct Care

The existing empirical work examining the cost of turnover for direct-care workers and low-wage service workers generally, suggests an overall accounting framework for costing turnover per worker at the **enterprise level**. This framework is presented in Table 3 and follows the literature in distinguishing between direct and indirect costs, and in identifying turnover-related productivity losses as an important category.⁹ Table 4 applies the framework to the empirical studies surveyed in the prior section of this report.

While the provider-level tends to be the main focus in turnover analysis, significant costs are also borne at two other levels which are also detailed in Table 3: the **service delivery level** where consumers actually receive the care delivered by frontline workers, and the **third-party payer level** where public funders and private insurers play major roles in designing, managing, and financing long-term care systems. Understanding these additional costs is critical to understanding the full cost burden of frontline turnover and leads to a fuller set of practice and policy implications.

Provider Enterprise Turnover Costs

Direct Provider Costs

Direct, out-of-pocket costs relevant to turnover of frontline workers in long-term care can be grouped into five main categories: 1) separation costs, 2) vacancy costs, 3) replacement costs, 4) training costs, and 5) the costs of worker injuries. Each of these sets of costs in turn is made up of a variety of cost elements that ideally should be tracked. The first four cost groups have to do with ongoing process of “leaving, hiring, and training”; the fifth accounts for the costs that providers must absorb when their direct care workforce sustains high on-the-job injury rates related to destabilized staffing levels and functions due to turnover.

Two categories of “leaving” costs can be distinguished: the costs of separating the employee who has quit or is being terminated from the organization and the costs of covering the vacant position until a new hire is in place. **Separation costs** include exit interviews and other processing, changes in unemployment tax, and separation pay if applicable. Overtime and temporary staffing are examples of **vacancy** costs. If an organization relies heavily on temporary staffing, and the pay differential between employees and temporary workers is significant, vacancy expenses may outpace training as the largest direct cost related to turnover.

Advertising is just one of the many possible cost inputs making up the composite expense of replacing a worker who has quit or been terminated. Other **replacement** costs include: screening applicants, interviewing, selecting candidates, physical exams, TB tests, Hepatitis B vaccinations, background verification, employment testing, and pay out of hiring bonuses.

A recent study of 15 relatively high-turnover organizations in Kansas providing community-based services to people with developmental disabilities found average advertising costs per leaver of \$112 in 2002 and \$104 in 2003 (Kansans Mobilizing for Workforce Change, 2004).¹⁰ Overtime per direct-care position added at least another \$1,000 annually. A 1998 survey of 23 of Alaska’s 28 developmental disability service providers found advertising and overtime costs of \$60 and \$1,272, respectively (Johnston, 1998). A major non-profit provider of services to persons with disabilities in Massachusetts reports overtime costs for 2004 of \$1,498 per replacement hire, \$831 for advertising, and \$1,948 in human resource staff time for recruitment and training (Vinfen Corporation, 2004).¹¹

Table 2: Frontline Turnover Cost Accounting**PROVIDER ENTERPRISE COSTS****Direct Costs**

- **Separation** (*exit interviews and administrative processing,, experience-rate increases in unemployment insurance, legal fees*)
- **Vacancy** (*additional overtime, use of temporary hires*)
- **Replacement** (*advertising, screening applicants, interviewing, selecting candidates, physical exams, TB tests, Hepatitis B vaccinations, background verification, employment testing and certification, hiring bonuses*)
- **Training & orientation** (*formal classroom training and on-the-job training*)
- **Increased worker injuries** (*lost days, experience-rate increases in Workers' Compensation*)

Indirect Costs

- **Lost productivity until replacement trained** (*inefficiencies attributable to departing employee, temporary staff (or vacancy), and new employee*)
- **Reduced service quality** (*penalties, fines, and lower quality measure ratings from regulatory & monitoring agencies, malpractice claims*)
- **Lost client revenues and/or reimbursement**
- **Lost clients (existing & potential) to other agencies due to deterioration in agency image, etc.**
- **Deterioration in organizational culture and employee morale adversely impacting reputation, service quality, and further increasing turnover**

COSTS AT SERVICE DELIVERY LEVEL**Consumer/Clients**

- **Reduction in quality of care and quality of life**
- **Care hours not provided**

Workers

- **Increased worker injuries**
- **Increased physical and emotional stress**
- **Deterioration in working conditions leading to increased likelihood to quit**

THIRD-PARTY PAYER COSTS

- **Underfunding of care services due to financial drain of turnover**
- **Increased downstream medical costs for Medicaid and Medicare due to illnesses and injuries attributable to reduced service quality**
- **Higher levels of institutionalization of clients due to insufficient community-based staffing & quality of care**

Training of replacement hires is often one of the largest, if not the largest, and most visible direct cost of turnover. The extent of training varies considerably across different types of providers, and is directly connected to the number of hours of training required for different positions. A recent study of long-term care providers in Pennsylvania (Leon et al., 2001) found that the median cost of training ranged from under \$200 for small personal care agencies to approximately \$750 for government-operated nursing homes.¹² The median cost of training in certified home health agencies was about \$480. A recent state-wide study of nonprofessional direct-care staff in Wyoming (Clabby II and Heinlein, 2001) found average training costs that were considerably higher than those reported in the Pennsylvania study: \$2,686 for developmental disabilities waiver providers, \$1,713 for nursing homes, and \$989 for hospitals.

Increased worker injuries result from disrupted organizational operations and poor working conditions. High turnover rates disturb the smoothness and continuity of care delivery, and result in increased physical and emotional stress to overworked direct-care workers. According to the Institute of Medicine (1996):

With sicker and more dependent patients than in the past, nursing homes have become more stressful and hazardous in terms of injuries. This situation is reflected in the high turnover among NAs [nursing aides] who do most of the heavy lifting. Understaffing (both quantitative and qualitative) leads to injuries, which leads to further understaffing and the needs of the patients go unmet. Often NAs are forced to lift residents alone when assistance is not immediately available.

Indeed, direct-care workers in nursing homes and personal care facilities experience some of the highest injury rates of any group of workers in the U.S. economy.¹³ According to the U.S. Department of Labor, in 2002 injury rates for direct care workers resulted in the second-highest number of occupational injuries and illnesses resulting in missed workdays, compared to all other occupational groups.¹⁴ Furthermore, musculoskeletal disorders (largely back injuries) are the most common type of injury suffered by direct care workers in both home-based and institutional settings, and these injuries are among the most serious and costly of workplace injuries (Service Employees International Union, 1997). The costs of unsafe working conditions obviously are borne directly by the workers themselves, but they also impact employers through lost work time on the part of injured workers and higher experience ratings for Workers' Compensation.

Indirect Provider Costs

While the distinction between direct and indirect costs borne by providers is not rigid, in general indirect costs are more difficult to measure than direct costs because they often are not experienced as out-of-pocket costs. For a generic company in the service sector of the economy, indirect costs stem from several sources: the lower efficiency and productivity of the departing employee, unproductive time for both colleagues and managers due to "team disruption," and loss of productivity while the new employee achieves full mastery of the job. All three of these effects constitute a "drag" on productivity. Potentially even more damaging to a business are lost sales and even lost customers. While the direct and

indirect costs of turnover link employee retention to cost-efficiency, it is the indirect costs that primarily impact revenue growth through customer acquisition and satisfaction.

While accounting for depleted productive capacity and reduced service quality in caregiving work or health care generally is challenging (Waldman et al., 2004), it is nonetheless possible, appropriate, and important. Indeed, it can be argued that turnover-induced problems are especially detrimental in human service organizations where productive capacity is concentrated in the knowledge, skills, and abilities of employees, and is in turn directly linked to service quality (Fullagar et al., 1998). In fact, there is reason to believe that these costs, which are more hidden from a strict out-of-pocket accounting perspective, actually account for the greater part of total turnover costs.¹⁵

Highlighted below are the key indirect costs of frontline turnover that are incurred by providers and mentioned in the literature:

Lost productivity refers to the cost of reduced productive capacity attributable to the lesser effectiveness of temporary employees, existing employees who are overextended, and the difference in the productivity of new employees compared to experienced employees who have achieved job mastery. A shorthand term for these losses is the cost of “ramping up” to the new staffing equilibrium. A recent study of turnover costs at a large medical center found that the cost associated with the lower productivity of new hires constituted from 42% to 66% of total turnover costs (Waldman et al., 2004). For “allied health personnel,” the costs of reduced productivity (from \$4,061 in a best-case scenario to \$10,709 in a worst-case scenario) dwarfed the costs of hiring and training per employee (\$720 and \$1,587, respectively).¹⁶

Reduced service quality (“quality of care”) can result from errors made by overburdened and fatigued workers, miscommunication, lack of adequate training and inadequate staffing, disrupted continuity of care, and de-personalized care. Considerable research has established the relationship between staffing levels and care outcomes for nursing homes residents (IOM, 2004). That quality of care suffers as turnover increases in health-related organizations is a related proposition that has considerable support in the health care and disabilities field generally, but which lacks extensive empirical research evidence.¹⁷ Strong arguments can be made that turnover adversely affects continuity of care and care recipient relationships, causing disruptions that prevent or interfere with the development of relationships critical to both client and caregiver.¹⁸ Frontline workers play an important role in monitoring the day-to-day physical and mental health of clients, allowing for more individualized and efficiently delivered care. High turnover causes the loss of this important source of information about patient well-being (Leon, 2001). Furthermore, turnover can produce staff shortages which result in rushed, de-personalized, or unsafe care.

Providers are affected by such lowered service quality when it results in health and quality measure deficiencies that are detected by inspectors and regulatory

agencies. Penalties and fines are possible consequences of such deficiencies, as are malpractice claims.

Lost client revenues or reimbursement. To the extent that turnover creates staffing shortages, caregiving hours may simply not be provided to clients.¹⁹ During these reduced service times, revenue from funding sources is forfeited, increasing financial pressure on provider agencies.

When a provider suffers lost revenue or reimbursement, a consumer experiences lost service or unprovided care hours. Consumers pay a high price when agencies create waiting lists or turn away potential clients, advising them to call other agencies. Even when the loss of services is temporary, clients and their families are likely to become upset. In addition, because providers at the community level are often tightly interconnected, other agencies coordinating with the short-staffed agency are disadvantaged in the scheduling of services for their clients.

Lost clients to other agencies. While in the short- to medium-term, long-term care agencies may experience lost revenues due to turnover, over the longer term, turnover may have a deeper, negative impact on provider financial stability by eroding the agency's capacity to acquire new clients or "business". Developing a reputation for high staff turnover and disrupted or understaffed care leads eventually to a deterioration in a provider's community image.

Deterioration in organizational culture and employee morale. High rates of turnover disrupt social and communication structures within provider agencies and lead to decreased satisfaction among the workers who remain. Wilner and Wyatt (1999) comment that "[t]urnover breeds more turnover as remaining staff lose morale, feel overworked and undervalued, or even become injured from lifting residents without a helper." This kind of deterioration in organizational culture and employee morale fosters further turnover, reduced productive capacity, and lower quality care.

Service Delivery Level Turnover Costs

Both consumer/recipients and direct care workers can be adversely affected by high turnover rates, incurring tangible costs that may not necessarily impact provider management decisions because they do not affect a provider's bottom line. On the consumer side, lower satisfaction, decreased care quality, and higher risk of injury and illness can result from staff vacancies, rushed or non-delivered care, and continual adjustment to new caregivers who don't know care-recipient routines and with whom care recipients lack relationships.

Consumers and their families directly bear the consequences of lower quality care, even when providers produce enough new workers to meet the requisite number of "days" or "hours" of care reimbursable by payers and counted by regulators. To the extent that community-based care hours authorized go undelivered, and/or care recipients' participation, mobility, and independence is limited by the effects of compromised quality care, consumers are put at greater

risk of institutionalization--a last-resort outcome that consumers and their families typically strive to avoid at all costs.

Worsening work environments due to turnover also can have adverse consequences for **frontline workers**. Increased physical and emotional stress is one type of cost that direct care workers absorb. When the stress reaches high levels and is ongoing, workers may respond by quitting their jobs. Another significant cost borne directly by workers in high-turnover environments is elevated on-the-job injury rates. As reported above, direct care workers experience some of the highest work-related injury rates of any occupation in the United States.

Third-Party Payer Turnover Costs

Compromised care quality can result in a higher prevalence of injury- and illness-related secondary conditions which in turn lead to increased institutionalization in more expensive, higher acuity settings, more emergency room visits and hospitalization days, and even higher mortality.²⁰ These adverse outcomes become part of the ripple effect of high turnover and inevitably raise costs to the long-term care and medical care systems.²¹ The vast majority of these “downstream” costs ultimately are borne by citizens whose tax dollars support the public programs that finance long-term care.

Possible downstream costs aside, high turnover costs constitute a financial drain on the payer streams that finance long-term care. From the perspective of the public sector, turnover costs borne by the system as a whole are tantamount to a “tax” that implicitly accompanies every day or hour of care services funded by taxpayer dollars.

Table 3: Direct Care Turnover Cost Studies (by cost element measured)

	1992 Zahrt	1998 Johnston	1998 Fullager	2002 Seninger & Tracy	1999 Straker & Atchley	1999 Straker & Atchley	2004 Larson	2004 Vinfen	2004 Waldman
	One homecare agency in Midwest	All DD providers in AK	All DD providers in KS (28)	7 DD providers in MT	100 home care agencies in OH	112 nursing homes in OH	Direct support providers in MN	Large, non-profit ID/DD provider in MA	Allied health personnel at medical facility in Southwest
Avg hourly wage	\$5.80	\$10.38	\$7.18	\$7.56-\$8.90	40%-76%*	88%-137%*	\$9.05	\$11.23	
Avg annual turnover	50%	166%	61%	77%			43%	22%	49%
Direct Costs									
Separation	X		X	X			X		
Vacancy	X	X	X	X				X	
Recruitment	X		X	X	X	X	X	X	X
Training & Orientation	X	X	X	X	X	X	X	X	X
Increased worker injuries									
Indirect Costs									
Lost productivity									X
Reduced quality of care									
Care hours not provided									
Lost client revenue									
Lost clients to other agencies									
Cost per worker	\$3,362	\$2,137	\$2,094	\$2,627	\$951 - \$1,242	\$1,885-\$2,100	\$2,592	\$5,276	\$6,368

* Computed, not reported rate.

IV. Conclusions & Implications for Practice, Policy and Research

Available studies conducted to date, in combination with estimates of turnover costs in other low-wage occupations, suggest that turnover among frontline workers is a critical cost driver for the long-term care industry. High staff turnover affects the fiscal health of providers, the quality of care that long-term care consumers receive, and the efficiency of resource allocation within the public payer system.

While many turnover costs are borne by providers, others are borne directly or indirectly by direct care workers themselves, by consumers and their families, and by the public sector. The potential magnitude of these costs, and the fact that key elements of the total cost of turnover are not visible or easily measured, lead to important implications for practice and policy, and for future research.

Implications for Practice

Evidence on the cost of per employee turnover within long-term care, in the context of high frontline staff turnover rates, leads to the conclusion that overall turnover costs borne by long-term care providers are substantial and constitute a significant financial drain on the bottom line. Several important implications for provider practice follow.

- **Know the true cost of turnover.**²² If long-term care providers see employee turnover as a necessary and inevitable cost of doing business, then they are likely to treat the costs of turnover as unrecognized expenses. However, the costs of recruiting and filling vacancies, lost productivity from vacant jobs, and the costs of training new employees should be tracked because they can affect operating costs, reduce or compromise “output” (in this case caregiving services), and cut into profits or the bottom line. High turnover drains provider finances, siphoning off money that might go into essential or innovative services. Uncovering these costs can be a wake-up call to individual providers. The studies reviewed in this report suggest that providers and researchers tend to underestimate turnover costs, usually failing to account for indirect costs.²³
- **Calculate turnover rates carefully.** Accurate computations of turnover rates as well as per-worker turnover costs are essential for making informed managerial decisions since the annual cost of turnover is a function of both numbers. In recent years, constructive steps have been taken towards establishing a uniform methodology for tracking turnover rates over time within and across care settings.²⁴
- **Reduce turnover costs by investing in effective retention strategies.** Far from being an inevitable cost of doing business, providers can measure and track turnover costs, make informed managerial decisions regarding how much they can afford to invest in keeping or retaining employees, and assess whether or not such investments are improving their bottom line. In short, the financial drain created by turnover can be diverted into programs and policies that encourage retention.

It is important to remember that turnover rates and costs at some level are indicators of provider efficiency in developing and retaining human assets, which are at core of the productive capacity of service industries. Knowing the cost of losing and then replacing an employee is helpful in determining how much investment can be afforded in keeping an employee. Understanding this cost will also help determine whether investment in keeping employees is helping an agency's bottom line.

While turnover and retention in long-term care are heavily influenced by state and federal policy, particularly, reimbursement rate cost structures that keep wages low, the costs associated with turnover of direct-care staff imply that providers can realize financial and other returns on their investments in retention strategies. In other words, this is an area where changes in provider practices have the potential to make a positive difference, independent of external state and federal policy.

The strict financial case for reducing turnover necessarily will be very sensitive to the particularities of each provider's cost structure and organizational infrastructure. For example, a relatively small agency with no dedicated human resource staff that outsources its training is likely to realize a greater proportional cost savings from reducing turnover than a larger agency with a dedicated human resource staff and regular, ongoing internal training for new employees. Expenses that the small agency experiences as *variable* may be experienced as *fixed* by the larger agency. In the former case, a linear relationship between the turnover rate and overall turnover costs may hold, which means that a 50% reduction in the turnover rate yields a 50% reduction in overall turnover costs. In the latter case, the relationship is probably nonlinear with a 50% reduction in turnover yielding less than a 50% reduction in overall turnover costs.

Implications for Policy

High turnover costs have serious financial implications for providers, but they also have fiscal impacts on the federal government, and on local and state governments, which together foot most of the bill for long-term care. Nursing homes, home health agencies, and community-based agencies providing services to individuals with developmental disabilities and mental retardation rely heavily on both Medicare and Medicaid to finance their operations. Through Medicaid, the state acts as the major third party payer for nursing home care and home care and consequently bears about 45 percent of the cost of high rates of turnover among direct-care staff. In some states, local governments are also responsible for contributing a mandated cost share. Medicare pays another 16 percent of long-term care costs. This financing structure for long-term care services makes turnover a budgetary concern at all levels of government, and an issue which conceivably is amplified during times of fiscal pressure or crisis, such as the current one.

The costs of turnover to the public sector are tantamount to an implicit tax on the reimbursement rates paid to publicly-financed providers -- a hidden tax which ultimately is paid by tax payers for high industry turnover costs. That the federal and state "price tags" for turnover in long-term care may be substantial is indicated by the following calculation:

- Assuming a long-term care workforce in the United States of roughly 2.6 million, an average annual turnover rate across all direct care occupations of 45%, and an average turnover cost of \$3,500 per direct care employee (including both direct and indirect costs borne by providers), then the national price tag for turnover is roughly on the order of \$4.1 billion.
- With Medicare and Medicaid paying 61% of total long-term care costs, the price paid by taxpayers for turnover in long-term care is approximately \$2.5 billion.

Note that these figures do not include the costs of increased health care costs due to lower care quality for consumers or higher injury-related medical costs for workers.

Indeed, a key characteristic of frontline turnover calculus is that costs do not accrue to providers alone but rather are incurred and borne at two other levels: by consumers and workers at the service delivery level and by third-party payers. Furthermore, costs at the service delivery and payer levels are not necessarily integral to the provider's cost/benefit calculus regarding turnover. In other words, providers may determine that it is not cost effective to make the investments needed to reduce turnover, but by not making those investments, substantial "downstream" turnover costs may be incurred by other stakeholders in the system -- consumers and their families, workers, and third-party payers.

However, through incentives, regulation, and support for best practices, public policy potentially can play an important role in creating better feedback mechanisms so that costs which are borne in one part of the system (e.g., increased medical costs due to lower quality care) are visible and taken into account by other stakeholders throughout the system. This can be accomplished through mechanisms such as rewarding organizations with low turnover, or creating information for consumers about staff turnover rates and aspects of care quality that are affected by turnover.

Two key areas for further policy analysis are suggested by this analysis:

- *Develop methods at both the state and national level for monitoring turnover costs in the full gamut of long-term care settings.* Just how big a role turnover cost plays in impeding a state's ability to adequately fund long-term care and other badly needed services for its citizens is something to be carefully investigated at both the state and national level.
- *Determine which public policies are likely to have the greatest impact on stabilizing the direct-care workforce, thereby reducing turnover, increasing retention, and reducing overall societal turnover costs.* Ideally, such an analysis would provide models for quantifying the offsetting savings due to turnover reductions so that the costs of new public investments in workforce development, including measures to fund higher wages and benefits, can be compared to the savings to various governmental bodies stemming from reduced turnover. Policy experiments relevant to this calculus are currently underway in many states, including legislated wage pass-throughs, mandated minimum starting wages and salaries, career advancement opportunities for

direct-care workers, and the implementation of incentive-based approaches that tie reimbursement for publicly-paid long-term care services to provider performance outcomes related to reduced turnover and increased retention.²⁵

While efforts to get a handle on the cost of turnover within the long-term care industry are at an early stage, the available evidence nonetheless indicates that turnover among the direct-care workers serving this industry exerts a significant financial burden on providers, with negative consequences for both the quality and quantity of services delivered by providers.

The inescapable conclusion is that direct-care turnover is a business problem, a quality of care problem, and a significant public resource problem. Because of its complex nature and the magnitude of the resources at stake, the cost of worker turnover in the long-term industry is a pressing issue that all stakeholders must work together to solve.

Implications for Research and Investigation

Field work and research are clearly needed in several areas. First, further improvements and refinements in both the statistical and fiscal measures used to measure turnover costs are in order, along with applications of these measures in the field in order to document actual turnover costs. The development of turnover cost calculators for different types of long-term care providers should be explored, with particular attention to practical, user-friendly ways of estimating the costs of lost productivity and reduced care quality.

A second area of research is the exploration of the links between turnover, on the one hand, and care quality, on the other. While the rationale for believing that high turnover negatively impacts quality is compelling, this association could benefit from more extensive empirical research. A recent report from the Centers for Medicare and Medicaid Services (CMS, 2002) recommends examining “whether there are critical turnover ratios above which patient quality is seriously compromised”, and “the relative importance of staffing levels and turnover or staff retention to quality problems.”

A related research area concerns the assessment of how care outcomes differ between high and low turnover environments. In addition to qualitative and observational studies, comprehensive, validated measures of health, functioning, and satisfaction, both objective and subjective, are needed to conduct this research, with attention given to assessments of care outcomes from multiple perspectives, including the consumer’s, the consumer’s family, and the care provider’s.²⁶

A final research area relates to improving our understanding of the sensitivity of turnover rates to different variables, since those rates along with turnover costs per employee determine overall turnover costs.²⁷ Reducing the rate of turnover may be the most effective way of reducing the overall cost, as there is arguably far less margin for reducing per-worker turnover costs. With regard to reducing turnover rates, three areas in particular deserve further investigation:

- The relationship between improved compensation and other retention strategies, on the one hand, and reduced turnover (and, therefore, lowered turnover costs), on the other. A technical term for this concept is the *elasticity of turnover with respect to compensation*—that is, the percentage change in compensation that results in a 1% drop in turnover.²⁸ Empirical evidence on this score is accumulating, with recent evidence from several states, including Wyoming, Michigan, Pennsylvania, and California.²⁹
- The *efficiency wage effects stemming from improved worker compensation and enhanced job desirability*. Efficiency wage effects refers to the gains from reduced turnover and absenteeism, lowered costs of supervising and replacing employees, and enhanced worker effort and productivity that can result from better jobs.³⁰ Research and empirical work is needed to develop economic models of efficiency wage effects for direct care.
- *Identifying and analyzing the factors differentiating low and high turnover organizations in long-term care, and determining the relative sensitivity of turnover to different variables*. Using data from a stratified sample of nursing facilities in eight states, Brannon et al. (2002) found that high and low turnover among nursing assistants were not associated with the same factors. These findings suggest that future studies of facility turnover should avoid modeling turnover as a linear function of a single set of predictors.³¹ In order to provide useful recommendations for practice (i.e., to managers of long-term care facilities and organizations), research is needed to determine which are the factors that have the greatest impact on turnover so that data collection and interventions can be directed to those dynamics.

ENDNOTES

¹ In this brief, the terms “frontline workers” and “direct-care workers” are used interchangeably and refer to CNAs, home health aides, personal assistants, and direct support professionals who provide support and assistance largely to elderly persons and people living with intellectual and developmental disabilities (ID/DD) in a variety of institutional, home, and community-based settings. The term “long-term care” is used to refer to care delivered across these various settings.

² Recent national surveys of nursing homes, home health agencies, assisted living, and community disability service providers (large state facilities only) show direct-care turnover estimates of 71%, 25%, 40%, and 28%, respectively, in these 4 settings. Use of different turnover measurement definitions, variation in sampling and weighting methods, and quality differences in respondent survey instructions across these surveys make comparisons problematic and also raise questions about the reliability of some of the estimates. In particular, the national turnover rate for aides in home health care strikes many practitioners as low. For turnover rates in nursing homes, see American Health Care Association (2003); for home care, see National Association for Home Care (2004); for assisted living facilities, see National Center for Assisted Living (2001); for developmental disability service providers, see Prouty, Smith, and Lakin, Eds. (2003), Table 1.32.

³ Training costs were relatively high because only 3 of the 50 aides came to the agency with a home care aide certificate. The agency sent its aides to a community college for the equivalent of 60-hours of classroom instruction. Zahrt (1992), pp. 62-63.

⁴ Allied health personnel are exclusive of physicians and nurses, and typically include: support services, behavioral scientists (social workers), therapeutic science practitioners, and laboratory technologists and technicians.

⁵ Mean annual wages for 2003 estimated by the US Bureau of Labor Statistics for the 3 main direct-care occupations are as follows: personal and home care aide \$17,020; home health aide \$19,180; and nursing aide \$21,050. One-quarter of the low and high end of the range yields, after rounding, approximately \$4,200 to \$5,200. See http://www.bls.gov/oes/2003/may/oes_nat.htm. For examples of applications of rule-of-thumb estimates of the cost of turnover in direct care, see Zabin (2003), and Pillemer (1996).

⁶ Hinkin and Tracey report that nearly the entire difference between the 2 estimates is attributable to different salary levels in the 2 labor markets, which implies that turnover costs in Miami are equivalent to those in New York after adjusting for wage differentials. The researchers also found that initial training cost accounted for no more than about one-third of total turnover costs. The cost of turnover as a percentage of total salary ranged from 27% to 30%.

⁷ Hinkin and Tracey computed actual learning costs by multiplying the daily wage by the number of workdays required to achieve competency while increasing the level of productivity in a linear manner over the time period. Peer disruption was calculated as “the percentage of decrease in productivity of an experienced worker caused by a new employee during the time when a new employee would have a question, need to be shown something, or have work assisted or corrected.” (p. 20)

⁸ This study—New Ideas for Retaining Store-Level Employees (Coca-Cola Retailing Research Council, January 2000)—found that employee turnover costs the typical supermarket \$198,977 a year, which translates into \$5.8 billion for the supermarket industry as a whole, a figure which exceeds the entire industry’s annual profit by more than 40%. See study summary at www.nationalgrocers.org/EmploTurnover.html. Other turnover cost studies by trade associations and human resource practitioner groups for employees earning \$8 per hour and under are summarized at the web site of a human resources company, Sasha Corporation, <http://www.sashacorp.com/turncost.html>, and range from \$3,500 to \$8,000. However, it is unclear what costs were included or excluded.

⁹ The chief indirect cost acknowledged in the business and human resource literature on this subject is that related to performance differential, i.e., the lost productivity attributable to the differential performance of the employee who leaves and the replacement employee. For an authoritative treatment, see Cascio (2000).

¹⁰ The percentage of direct care workers who quit their jobs within 6 months of being hired was 51% in both years; turnover rates were 55% in 2002 and 58% in 2003.

¹¹ The cost of human resource staff time per replacement hire was calculated by Vinfen at 50% of the organization's entire human resource (HR) and training budget (\$1.66 million) divided by the number of annual replacements which typically exceeds 400 a year. About half of the organization's HR staff of 18 people work nearly exclusively on recruiting, screening, and training new direct-care replacements as well as processing workers who leave.

¹² Mean training costs ranged from about \$250 to just over \$1,500.

¹³ In 2002, the occupational injury rate for employees of nursing and personal care facilities was 13 injuries per 100 employees, compared to 7 injuries per 100 employees for construction workers. See the latest release of the U.S. Bureau of Labor Statistics on workplace injuries and illnesses (December 2003), available at www.bls.gov/iif/oshwc/osh/os/osnr0018.txt.

¹⁴ Teresa Scherzer, Susan Chapman, and Robert Newcomer (not dated) "Lost-worktime injuries and illnesses of Nursing Aides, Orderlies, and Attendants." San Francisco, CA: Center for Personal Assistance Services, University of California. www.pascenter.org/lost_workdays.

¹⁵ In RN turnover, for example, the American Organization of Nurse Executives estimates that visible costs represent 24% of total costs for medical/surgical nurses and only 18% for specialty nurses. "In dollar amounts, the typical accounting of turnover estimates \$10,800 in turnover costs for each medical/surgical nurse and \$11,520 for each specialty nurse." Hidden costs bring the total costs of turnover to \$42,000 for the first category of nurse, and \$64,000 for specialty nurses, where hidden costs include: the lost productivity of the incumbent and of other employees in the period leading up to the departure, lost productivity of the vacant position and of other employees who are hampered during the time a position is unfilled, and finally, lost productivity of the new hires during their learning period, along with the costs of the other nurses teaching or mentoring the new employee until they are up to speed or other nurses simply being slowed down by having someone new as part of the staff. See Lafer (May 2003) Chapter on the "Cost of Failure."

¹⁶ Cost of reduced productivity (CoRPs) was estimated by using employee learning curve algorithms and inputting 4 factors (percent starting efficiency, time to job mastery, annual salary, and retention rates). The factor values were derived from interviews with managers at all levels of the medical center. CoRPs were calculated for 2 different learning curves: a straight line (linear) and a Pareto relationship where 80% of the learning occurred in the first 20% of the time to achieve job mastery. See Waldman et al. (2004).

¹⁷ For a review of the status of research regarding the link between turnover and quality, see CMS (2002) and IOM (2004).

¹⁸ For perspectives from direct support staff, administrators, and consumers regarding the impact of turnover on the quality of care and service, see Test et al. (2003). Reif argues that "[i]n long-term care, the length of match between employee and employer actually can be used as a direct measure of quality, because it consistently appears as directly related to consumer satisfaction in consumer surveys (Reif, 2002). Why the stability of these matches matters is well-summarized by Leon et al. (2001, p. 15).

¹⁹ See Hatton and Dresser (October 2003), Dawson and Surpin (2001), Wunderlich et al. (1996), Harrington (1996), and Burger et al. (2000).

²⁰ See Traci, Szalda-Petree, and Seninger (1999), Taylor (2002), SEIU California (2004), and Kosel and Olivo (2002) and sources cited therein.

²¹ For example, pressure sores can result when clients are not properly fed, or are poorly hydrated, cleaned or kept mobile; urinary incontinence can be caused by lack of help with toileting. See Traci, Szalda-Petree, Seninger (1999) and Kosel and Olivo (2002) for evidence on higher average cost per discharge, including hospital stays.

²² This advice is also given in Richard Hoffman (April 2001) "The Revolution in Creating a Successful CNA Retention Program" Nursing Homes Magazine.
http://www.nursinghomesmagazine.com/Past_Issues.htm?ID=240.

²³ Straker and Atchley (1999, p. 26) report that in their study, "most nursing homes and home health agencies dramatically underestimated the extent of their turnover problem and did not collect adequate data on the extent and cost of turnover. Consequently, long-term care employers were in a poor position to evaluate the financial trade-off that might be made."

²⁴ See the turnover instrument proposed by the Institute for the Future of Aging Services (2003).

²⁵ See PHI & IFAS (2003) and PHI & NC Department of Health & Human Services' Office of Long Term Care (2004).

²⁶ For a review of existing quality measures and indicators used in Medicare- and Medicaid-certified nursing homes and home health agencies, see AHRQ (2003).

²⁷ Specifically, total annual turnover costs for a provider agency are equal to the product of the agency's average annual turnover rate and average annual per employee turnover costs.

²⁸ See Zabin (2003, p. 9) for development of this concept. As an example of this kind of relationship, using data from a recent study from Wyoming which reported on the reduction in turnover over a three-month period due to an increase in hourly wages, Zabin calculates that every 10% increase in compensation is associated with a 5.7% reduction in turnover. A full year of data from Wyoming is not yet available.

²⁹ For California, see Wheeler, Kurtz, & Smith (2002), Howe (2002). For Wyoming, see Clabby II and Heinlein (December 2001)

³⁰ See Pollin and Brenner (2000, p. 93) for references to the literature on efficiency wage effects. See O'Brien (2003) for an interesting exposition of the "business case" for employment-based health coverage.

³¹ Swan (2002) cautions that, since there is no consensus on what constitutes optimal turnover rates, care must be taken in setting a low turnover rate cutoff based solely on statistical patterns.

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The delta variant is putting America's hospitals back in crisis mode

By [Frances Stead Sellers](#), [Ariana Eunjung Cha](#), [Hannah Knowles](#) and [Derek Hawkins](#)

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With only about half of the U.S. population fully vaccinated against the novel [coronavirus](#), hospitals across the country are straining to respond to a deadly fourth surge of infections driven by the delta variant.

Doctors say the nationwide outbreak overwhelming hospitals could have been avoided had more people been immunized. In the week ending Tuesday, 46 of the 50 states experienced double-digit growth in covid-19 hospitalizations, according to an analysis by The Washington Post. Eight states, including California and New York, which for most of the summer had not seen many serious cases, added more than 400 new inpatients in that time.

“It’s absolutely due to delta; it’s absolutely due to unvaccinated people,” said David Wohl, a specialist in infectious diseases at the University of North Carolina. “There is an incredible increase in hospitalizations across the spectrum, from just needing oxygen and some care to needing serious interventions to keep people alive. If everyone was vaccinated, our hospitals would not be anywhere near where we are,” Wohl said.

In rural Grants Pass, Ore., Asante Three Rivers Medical Center was already busy this summer. The hospital was struggling to fill positions, and people who had put off medical care during the pandemic were finally coming in.

Then came the new wave of serious covid-19 cases — far more than the center had seen [even in January](#). The entire critical care unit was filled Monday with unvaccinated patients, and a heartbroken doctor just told seven cancer patients their surgeries would have to wait. For the first time ever, the hospital is doubling up patients in critical care rooms where normally each would have had privacy.

“If you would have asked me ... would we ever be there? I would have said, ‘God, I hope please we don’t get there,’” said hospital chief executive Win Howard, as some staffers doubled their hours and a nearby county asked the state for a 300-bed field hospital. “We are there today. It’s a sad day.”

The numbers paint a grim picture. For the week ending Aug. 15, the country reported 911,529 new infections, with an average of more than 130,000 cases a day, according to tracking by The Post.

The last time the weekly infection count was that high was the week ending Jan. 31, when the country logged 1,032,785 new infections, Post data shows.

At the time, vaccines were available only to vulnerable segments of the population.

The impact on hospitals is at once distressingly familiar and strikingly different from previous surges, clinicians say. In addition to handling mounting covid-19 case numbers, hospitals are playing catch-up on elective surgeries that were postponed because of the pandemic. People are out driving on the roads and playing sports, experiencing accidents and injuries, and increasing the burden on trauma departments. Common viruses are again spreading as people get

and injuries, and increasing the burden on trauma departments. Common viruses are again spreading as people get together — and cases of respiratory syncytial virus (RSV) are filling up pediatric hospital beds. And administering new therapeutics, including monoclonal antibodies, is time-consuming.

All of this is putting extra demands on staffers who have not yet been able to process the previous surge, let alone rest. Now they are treating deathly sick patients who are younger than before — but would almost certainly not be in the hospital if they had been vaccinated.

“It’s kind of like running a race. We knew the finish line was a vaccine. Now, whoop, there is another half marathon in front of you,” said Lisa Clark Pickett, chief medical officer at Duke University Hospital in North Carolina. “We have seen so much death, and now it’s young people dying of things we can prevent.”

Pandemic burnout and other factors have also made hiring harder, said Jeff Absalon, chief physician executive for St. Charles Health System in Oregon, which is trying to fill some 800 open positions — more than double what might be seen in normal times. The health system has brought in about 100 traveling nurses.

“All of those things happening at the same time ... created this environment that we’re in right now,” he said.

With hospitals consistently full, Absalon’s health system scrambled this past weekend to open a new urgent care clinic at a site that’s normally used for primary care. Absalon is also having “extreme difficulty” discharging patients to skilled nursing facilities and assisted-living centers because of staffing shortages in those facilities, Absalon said. St. Charles Health System has started sending some of its employees to those facilities to provide care outside the hospital.

Greg Martin, a critical care doctor at Emory Healthcare in Atlanta and president of the Society of Critical Care Medicine, said that a few weeks ago, Atlanta was quiet. Since then, there has been a tenfold increase in the number of hospitalized patients — from 10 to more than 100 today.

“It’s remarkable how quick this surge has come on,” he said.

Hilo Medical Center on the Big Island of Hawaii just welcomed its first “relief workers” — 11 nurses and one respiratory therapist sent by FEMA and other authorities, said Elena Cabatu, director of public affairs. Now some staffers who have been “going nonstop for so long” can rest.

Cabatu wonders how sustainable that kind of help is when covid-19 cases are spiking around the country.

“If you look on the map, it’s red all over the place,” she said.

Many ER departments are particularly stressed because they have been giving remdesivir or monoclonal antibodies to patients who are showing signs of illness but are not sick enough to be hospitalized, according to Mark Rosenberg, president of the American College of Emergency Physicians and chair of emergency medicine at St. Joseph’s Health in Paterson and Wayne, N.J. The testing, preparation, infusion and observation can take a half-day or more.

“If you are seeing several hundred patients a day and a high percentage have covid and require treatment, this takes up a lot of resources and adds a lot of hours during the day,” Rosenberg said.

The strains on staffers reflect grim statistics. Don Williamson, president of the Alabama Hospital Association, said he has been watching the virus march up the state, starting with the counties abutting Florida, where more than 16,800 people are hospitalized with covid-19, occupying more than 30 percent of the state’s beds, according to federal data.

In Alabama, more than 2,700 covid patients are hospitalized, about 400 fewer than the peak in January. But, Williamson said, ICU beds are already packed, even as hospitals adapt to provide more. The percentage of inpatients under 35 has increased from 8 or 9 percent to 16 percent. Back “in the golden days of June,” Williamson said, there were only about two or three pediatric covid patients in Alabama hospitals each day. Now that number is closer to 40.

Wohl, who monitors a dashboard that tracks hospital admissions at UNC, saw an uptick a couple of weeks after July 4.

The delta variant, which delivers huge numbers of virus and accounts for nearly 100 percent of all new covid-19 cases, has presented new challenges, Wohl said, occasionally finding unexpected cracks in people's immune systems sometimes even after they have been vaccinated. But in the vast majority of cases, people who get sick are unvaccinated.

"It's extremely rare to see somebody vaccinated struggling to stay alive," Wohl said.

The new variant has surprised experts in infectious diseases, according to Aaron Glatt, the chief of infectious diseases and the hospital epidemiologist at Mount Sinai South Nassau on Long Island.

With delta, "we are dealing a lot with guesses without knowing every piece of information that we'd ideally want to have," Glatt said, adding that he is very concerned about the next few months.

"Nothing that I thought was going to happen happened," Glatt said. "Delta is much more serious and contagious than I thought it would be."

Many hospitals are already cutting back on routine work. Duke University Hospital has begun canceling some surgeries, including joint replacements and non-urgent hysterectomies.

"We hate to do that; it has long-term consequences," Pickett said.

In Oregon, Howard said that earlier in the pandemic, moves there to cancel elective surgeries were preemptive and mandated by the state. Now such deferrals are simply necessary, he said: The three-hospital system of which Three Rivers is a part has scrapped or pushed back hundreds of surgeries.

The system is licensed to operate 552 beds and is asking to add more than 100. It is also trying to fill about 550 job openings, far more than usual, and is turning more rooms into critical care spaces to handle coronavirus patients.

It's not just the hospitals that are under pressure. The local ambulance companies are overwhelmed, too, Howard said. So are the skilled nursing homes to which medical centers say they have increasingly struggled to discharge patients, even before the delta wave. Open beds just aren't staffed.

"We are averaging about 60 patients a day in our hospitals that don't need to be there [but remain] because we can't get them placed," Howard said.

Tanya Phillips, an official with nearby Jackson County public health, said the entire public health system is strained, making contact-tracing difficult. Their region — Jackson and Josephine counties, including Grants Pass — had 163 people hospitalized with covid-19 on Monday.

The old peak, on Jan. 2, was 69.

The current situation "doesn't really compare to what we saw during that fall and winter surge," Phillips said. "It's pretty surreal," she added, saying 15 of the current covid-19 patients are on ventilators.

Wohl, the infectious-disease specialist at UNC, said that medical professionals are accustomed to treating people who have made bad decisions such as smoking, using drugs or driving dangerously. What is new this time, he said, is that they are treating people whose decision to forgo vaccination is, in many instances, based on misinformation and political manipulation.

"We sabotaged ourselves," Wohl said. "It's like watching the same house burn down time and time again."

Jacqueline Dupree contributed to this report.

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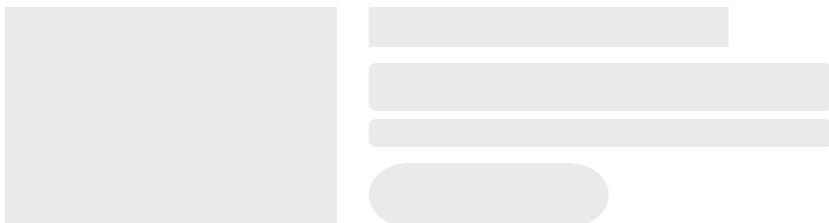
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COMMENTARY

The Devastating Impact of Covid-19 on Individuals with Intellectual Disabilities in the United States

A study across 547 U.S. health care organizations finds that individuals with intellectual disabilities are at substantially increased risk of dying from Covid-19.

By Jonathan Gleason, MD, Wendy Ross, MD, Alexander Fossi, MPHc, Heather Blonsky, MAS, Jane Tobias, DNP, RN, MSN, CPNP-PC & Mary Stephens, MD

March 5, 2021

Summary

A cross-sectional study of 64,858,460 patients across 547 health care organizations reveals that having an intellectual disability was the strongest independent risk factor for presenting with a Covid-19 diagnosis and the strongest independent risk factor other than age for Covid-19 mortality. Screening for Covid-19, care coordination, and vaccination efforts should be intense within this population that is less able to consistently use masks and socially distance.

Individuals with intellectual disabilities have poor health outcomes.^{1,2} Life expectancy for this population and those with developmental disabilities is nearly 20 years below that of the general population, and mortality for those with intellectual disabilities is significantly higher across their lifespan.³ Increased mortality in those with intellectual disabilities is caused by a number of factors and the impact of each is not well explored; in some cases,

the cause of their disability or complications associated with their disability (in particular, difficulties with aspiration) may contribute to higher risk of mortality.⁴ In other cases, socioeconomic factors, obstacles to receiving the full amount of health care to which they should be entitled, and obstacles to effective advocacy for this population may contribute to an inability to receive appropriate and effective health care, which in turn leads to increased morbidity and mortality.³

Several smaller studies have demonstrated the effects of the pandemic on those with intellectual disabilities. One report demonstrated a higher case fatality rate for individuals with intellectual disabilities in California (.055 compared with .019 among the general population).⁵ A similar study of New York State residents found that those with intellectual disabilities or developmental disabilities were at greater risk of mortality, with those in residential group homes at especially high risk owing largely to elevated case rates. In this study, the mortality of those with intellectual disabilities and developmental disabilities was nearly 8 times higher than the general population, illustrating the severity of the risk that this population faces.⁶ The largest study of intellectual disability and Covid-19 outcomes examined claims data from 467,773 patients who received Covid-19 diagnoses between April and August of 2020. This study found that those with developmental disabilities were over 3 times as likely to die following a diagnosis of Covid-19 and that those with intellectual disabilities were 2.75 times as likely to die following such a diagnosis.⁷

While it is clear that individuals with intellectual disabilities are at higher risk for dying from Covid-19, the full impact of Covid-19 on individuals with intellectual disabilities across the United States remains unclear. The current study utilizes a large national sample of patients to describe the relative impact of Covid-19 on individuals with intellectual disabilities versus the general population. We hypothesize that individuals with intellectual disabilities are at significantly elevated risk of contracting Covid-19 and that they will subsequently be admitted to ICUs and/or die in-hospital more often.

Methodology

This is a cross-sectional study across 547 health care organizations in the United States from January 2019 through November 2020 using the Vizient Clinical Database/Resource Manager (CDB/RM). The CDB/RM includes patient data from an analytic platform for

performance improvement populated by hundreds of health systems and community hospitals nationwide, including nearly all academic medical centers. Covid-19 was identified by a principal or secondary diagnosis code of U07.1 starting in April 2020, or in March 2020 with either a principal diagnosis of B97.29, or a secondary diagnosis of B97.29 with a principal diagnosis of J12.98 or J12.9 (viral pneumonia), or a diagnosis-related group in the following list, representing respiratory diseases, infections, and sepsis: 177, 178, 179, 207, 208, 853, 854, 855, 870, 871, or 872.

“

Covid-19 has had a devastating impact on individuals with intellectual disabilities. In this study, having an intellectual disability was the strongest independent risk factor for presenting with a Covid-19 diagnosis and the strongest independent risk factor other than age for Covid-19 mortality.”

The intent was to describe the impact of the population of established patients across 154 health systems. The population includes all patients with a medical record that predates an encounter with a Covid-19 diagnosis. Jefferson’s Institutional Review Board certified that the study methodology did not constitute human subjects research and as such was not subject to review on January 25, 2021.

Patient Status Definitions

The “Patients with Intellectual Disabilities” group is defined as distinct patients seen by any member location between January 2019 and November 2020, with a diagnosis code of F70-F79 (intellectual disability). Codes are not always consistently recorded across all encounters, so patients who are not recorded as having an intellectual disability when they are diagnosed with Covid-19 might have had a diagnosis of intellectual disability in a previous encounter. In this analysis we have summarized each patient record so that any diagnosis of intellectual disability on any encounter since January of 2019 can identify a patient in this group.

The “Patients with No Intellectual Disabilities” group is all member system patients from the same time period, excluding those in the Patients with Intellectual Disabilities group.

Patients who have no record of care at the institution they presented to with Covid-19 prior to their Covid-19 diagnosis were defined as “New Patients.”

Patients in any of the payer categories listed in Table 1 were defined as “Payer Group Suggesting Low Socioeconomic Status.”

Table 1.



Payer Groups Suggesting Low Socioeconomic Status and Comorbidities

Payer Groups Suggesting Low Socioeconomic Status

Medicaid Traditional/Indemnity

Medicaid Transplant Network

Medicaid/Managed Care

Medicaid (not otherwise specified)

Title V Maternal & Child Health Traditional/Indemnity

Title V Maternal & Child (HMO)

Title V Maternal & Child Health (not otherwise specified)

County Medically Indigent Services Traditional/Indemnity

County Medically Indigent Services (not otherwise specified)

Charity Traditional/Indemnity

Charity (not otherwise specified)

Self-Pay — Uninsured (not otherwise specified)

Comorbidities

Congestive heart failure

Pulmonary circulation disorders

Hypertension (with or without complications)

Comorbidities

Neurological disorders

Lung disorders

Diabetes (with or without complications)

Thyroid disease

Chronic kidney disease

Liver disorders

Oncology (leukemia, lymphoma, and solid organ)

Coagulopathy

Obesity

Malnutrition

Fluid/electrolyte disorders

Deficiency anemia

Source: The authors.

Comorbidities

Elixhauser comorbidities definitions and their equivalent ICD-10 diagnosis groupings across the continuum of care were utilized. Comorbidities that were included are those that were documented prior to the diagnosis of Covid-19, and those that were included are listed in full in [Table 1](#).⁸ Behavioral health comorbidities were excluded, as was any comorbidity that did not affect at least 10% of the patient population, diagnoses, or deaths.

Outcomes

Diagnosis and admission were defined by patient status within the CDB/RM. Note that “Covid-19 diagnosis” in this analysis specifically refers to presentation with Covid-19 at the provider institution, meaning that patients who were screened and treated at other institutions or those who had mild cases and did not present were excluded from analysis.

Admitted patients are counted only once, regardless of readmissions. ICU stay and inpatient mortality were also defined by patient status. Patients with multiple ICU stays are counted only once.

Regression Models

Multivariate logistic regression models include intellectual disability as a factor in the model to evaluate the associations of intellectual disability with increased risk of Covid-19 diagnosis, admission, ICU stay, and mortality, in the context of all of the other comorbidities as well as demographic factors (age, gender, race/ethnicity, payer-based socioeconomic status). Odds ratio for mortality among admitted patients is calculated on patient records with a Covid-19 diagnosis and admission with Covid-19 (without regard for diagnosis rank).

Results

The study population include records of 64,858,460 patients in total, of which 128,074 were patients with intellectual disabilities and 64,730,386 were patients without intellectual disabilities.² The data set included 443,965 “new patients” with Covid-19, but these were excluded from analysis as corresponding records for new patients without Covid-19 did not exist within the data. This left a data set of 64,414,495 patients, of which 127,003 were patients with intellectual disabilities and 64,287,492 were patients without intellectual disabilities.

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The risks to patients with intellectual disabilities incorporate not only risks associated with intellectual disability itself, but also the risks associated with these comorbidities that were overrepresented among those with intellectual disabilities.”

Of these, 558,672 (0.87%) presented with a diagnosis of Covid-19. Established patients with intellectual disabilities had higher rates of Covid-19 incidence than those without intellectual disabilities and with Covid-19 (3.1% vs 0.9%, $p < .001$), and were more likely to be admitted to the hospital if diagnosed (63.1% vs. 29.1%, $p < .001$). Those with intellectual disabilities and a diagnosis of Covid-19 had higher rates of ICU stay (14.5% vs. 6.3%,

p<.001), and patients with intellectual disabilities were more likely to die following diagnosis of Covid-19 (8.2% vs. 3.8%, p<.001). Those with intellectual disabilities were more likely to be existing patients of the institution where they presented with Covid-19 (22% new patients compared with 44% of those without intellectual disabilities), less likely to be in a higher age group (1% over 80 and 18% from 60–80 compared with 5% and 25% in the general population, respectively), and more likely to have a health care payer status associated with low socioeconomic status (44% vs. 28%, p<.001). Patients with intellectual disabilities also had higher rates of all comorbidities other than cancer prior to Covid-19.

Logistic Regression Models

The adjusted odds ratio for intellectual disabilities and Covid-19 diagnosis among established patients was 2.584 (95% CI 2.501–2.669). The adjusted odds ratio for intellectual disabilities and Covid-19 admission among those diagnosed was 2.739 (95% CI 2.490–3.014). There was no significant association of intellectual disabilities with ICU stay among admitted patients, with an odds ratio of 1.039 (95% CI 0.941–1.147). The adjusted odds ratio of inpatient mortality among those with intellectual disabilities admitted with Covid-19 was 1.324 (95% CI 1.165–1.505). Among all established patients, the odds ratio of mortality due to Covid-19 among those with intellectual disabilities was 5.909 (95% CI 5.277–6.617). These regressions are presented in [Table 2](#) and [Figure 1](#), [Figure 2](#), [Figure 3](#), and [Figure 4](#).

Table 2.



Study Population Descriptives, Covid-19 Incidence, and Covid-19 Outcomes

	Patients with No Intellectual Disabilities	Patients with Intellectual Disabilities
Total Patients in Data Set	64,858,460	
Total Established Patients Prior to Covid-19	64,414,495	
Distinct Patients	64,730,386	128,074

	Patients with No Intellectual Disabilities	Patients with Intellectual Disabilities
• Established Patients Pre-Covid-19	64,287,492	127,003
• Established Patients with Covid-19	554,775 (0.9%)	3,897 (3.1%)
• Additional New Patients with Covid-19*	442,894	1,071
• Total Covid-19 Diagnoses	997,669	4,968
• “New” Covid-19 patients	44%	22%
Covid-19 Admissions — Established Patients Only	165,163 (29.1% of diagnoses)	2,459 (63.1% of diagnoses)
• ICU Stay	35,139 (6.3% of diagnoses)	565 (14.5% of diagnoses)
• Mortality	21,277 (3.8% of diagnoses)	321 (8.2% of diagnoses)
% Female (number) — Established Patients Only	56.7% (36,478,292)	43.4% (55,050)
Distribution of Ages — Established Patients Only		
• Under 20	11,931,901 (18%)	26,932 (21%)
• Age 20–39	16,693,973 (25%)	42,266 (33%)
• Age 40–59	17,630,106 (27%)	35,986 (28%)
• Age 60–79	16,572,219 (25%)	22,906 (18%)
• 80 and Over	3,606,912 (5%)	1,620 (1%)
Payer Group Suggesting Low Socioeconomic Status	18,252,574 (28%)	56,917 (44%)
Mortality Among Established Patients (Includes ED Mortalities)		

	Patients with No Intellectual Disabilities	Patients with Intellectual Disabilities
• Under 20	0.0002% (27)	0.0038% (1)
• Age 20–39	0.0025% (403)	0.0602% (25)
• Age 40–59	0.02% (2839)	0.30% (106)
• Age 60–79	0.07% (10760)	0.75% (167)
• 80 and Over	0.21% (7428)	1.40% (22)

Mortality Among Admitted Patients (Established Only)

• Under 20	0.65% (22)	0.82% (1)
• Age 20–39	1.76% (387)	5.24% (24)
• Age 40–59	6.65% (2758)	12.10% (102)
• Age 60–79	16.06% (10528)	16.67% (158)
• 80 and Over	24.36% (7023)	25.00% (22)

Rates of Comorbidities Pre–Covid-19:

• Congestive Heart Failure	2,108,408 / 3.3%	6,994 / 5.5%
• Pulmonary Circulatory Disorders	1,216,665 / 1.9%	4,093 / 3.2%
• Hypertension	14,425,308 / 22.4%	38,654 / 30.4%
• Neurological Disorders	9,405,049 / 14.6%	68,035 / 53.6%
• Lung Disease (Asthma & COPD)	5,613,511 / 8.7%	21,655 / 17.1%
• Diabetes	7,934,598 / 12.3%	26,162 / 20.6%
• Thyroid Disorders	4,479,283 / 7.0%	20,041 / 15.8%

	Patients with No Intellectual Disabilities	Patients with Intellectual Disabilities
• Chronic Kidney Disease	2,682,036 / 4.2%	8,919 / 7.0%
• Liver Disease	2,917,538 / 4.5%	10,137 / 8.0%
• Oncology	5,908,421 / 9.2%	7,904 / 6.2%
• Coagulopathy	1,341,944 / 2.1%	7,826 / 6.2%
• Obesity	5,324,014 / 8.3%	24,306 / 19.1%
• Malnutrition	3,240,367 / 5.0%	19,703 / 15.5%
• Fluid/ Electrolyte Disorders	4,339,274 / 6.7%	29,071 / 22.9%
• Deficiency Anemia	4,168,169 / 6.5%	21,154 / 16.7%

*Analysis excludes these patients. Source: The authors.

Figure 1 .



Figure 2 .



Figure 3 .



Figure 4 .





Discussion

Having an intellectual disability is the strongest independent risk factor for having a Covid-19 diagnosis among a large patient population in the United States. These data corroborate findings in the available literature that indicate that those with intellectual disabilities are more likely to contract Covid-19. Those with intellectual disabilities were the identified clinical group at highest risk of presenting with Covid-19 in this study compared to those without intellectual disabilities. These risks persisted after regression to control for common comorbidities, but it is worth noting that these comorbidities were especially common among those with intellectual disabilities.

The risks to patients with intellectual disabilities incorporate not only risks associated with intellectual disability itself, but also the risks associated with these comorbidities that were overrepresented among those with intellectual disabilities. If diagnosed with Covid-19, patients with intellectual disabilities were more likely to be admitted to the hospital, and while they were not more likely to be admitted to the ICU following an admission, they were more likely to experience mortality due to Covid-19 following an admission. These

odds of mortality in this population is significantly higher than other conditions such as congestive heart failure, kidney disease, and lung disease.

“

Beyond the direct risk of Covid-19, the pandemic has had negative effects on the ability of individuals with intellectual disabilities to receive the health care and daily support that they typically receive.”

The risk of exposure in this population can be explained by a number of factors, including the need for daily care that many with intellectual disabilities have, which requires regular contact with home-care support personnel and others, use of shared transportation, and in many cases residence in high-contact housing such as long-term care facilities. Some individuals with intellectual disabilities have sensory issues that make tolerating mask-wearing for long periods of time difficult. Cognitive impairments and communication difficulties also raise the question of need for family or caregiver support when hospitalized.

Beyond the direct risk of Covid-19, the pandemic has had negative effects on the ability of individuals with intellectual disabilities to receive the health care and daily support that they typically receive. Providers who are not cognizant of this medical limitation may incorrectly turn them away, even though this limitation is covered by the Americans with Disabilities Act. A lack of typical supportive services may lead to increased behavioral issues and treatment with psychotropic medication with negative side effects, including weight gain. These risk factors and the additional barriers previously discussed indicate that increased resources are needed to vaccinate this vulnerable population and those who provide direct care, to prevent Covid-19 infection.

It is notable that the inpatient mortality is elevated in this group, but ICU admission was not elevated. This raises questions about whether critically ill patients with intellectual disabilities are less likely to be transferred to a higher level of care, or if this reflects differences in advanced care planning in this population. Further study is needed in this area.

The data considered here have a number of limitations. We are unable to track patients across different health care providers, meaning that the incidence rates of Covid-19 among established patients presented are not indicative of the overall incidence of Covid-19. For comparison, the rate of Covid-19 diagnosis reported in this study was 0.87% as of November 2020, while the overall incidence reported in the United States at that time was 2.91%.¹⁰ This study also excluded patients who presented at institutions in the data set with a diagnosis of Covid-19 who were not established patients of those institutions.

There is a general limitation on reporting of intellectual disabilities diagnosis; many patients with intellectual disabilities may not have that diagnosis reflected in their medical record. In our sample, 0.2% of patients had a recorded diagnosis of intellectual disabilities in their medical record; while prevalence of intellectual disabilities among adult populations is not well established, studies have estimated it at 0.52%–1.37%.¹¹

Conclusion

Covid-19 has had a devastating impact on individuals with intellectual disabilities. In this study, having an intellectual disability was the strongest independent risk factor for presenting with a Covid-19 diagnosis and the strongest independent risk factor other than age for Covid-19 mortality. Patients with intellectual disabilities and their caregivers should be prioritized for vaccination and health care services.

While the needs of this population due to Covid-19 clearly require immediate attention, these results also reflect existing limitations of the health care system as they pertain to individuals with intellectual disabilities.

Jonathan Gleason, MD

Chief Quality Officer, Jefferson Health, Philadelphia, Pennsylvania, USA

Wendy Ross, MD

Director, Center for Autism & Neurodiversity, Jefferson Health, Philadelphia, Pennsylvania, USA

Alexander Fossi, MPHc

Research Coordinator, Center for Autism & Neurodiversity, Jefferson Health, Philadelphia, Pennsylvania, USA

Heather Blonsky, MAS

Data Scientist, Vizient, Inc., Irving, Texas, USA

Jane Tobias, DNP, RN, MSN, CPNP-PC

Assistant Professor, Jefferson Health, Philadelphia, Pennsylvania, USA

Mary Stephens, MD

Assistant Professor, Family and Community Medicine, Jefferson Health, Philadelphia, Pennsylvania, USA

Disclosures



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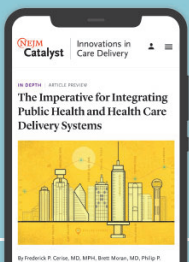
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